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Coal Development In Rural America

The Resources at Risk

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Abstract

U.S. coal reserves are huge and are concentrated mainly in three regions—the Northern Great Plains, the Interior Region, and the Eastern Region. Future coal production will likely shift toward the West. Coal development, especially strip mining, competes with agriculture for both land and water; however, it should not require enough land to seriously threaten U.S. agricultural production. Although costly, reclamation of strip-mined land can alleviate the potential long-term damage to land resources.

KEYWORDS: Coal development, strip mining, coal production, population, economic impacts, mined land reclamation, landownership, land use, resource competition, agricultural production, water requirements

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Preface

The research activities and results described in this report are part of a project, "Integrated Assessment: Economic and Social Consequences of Coal and Oil Shale Development," supported jointly by the U.S. Department of Agriculture (USDA) and the Environmental Protection Agency (EPA) as a component of the Federal Interagency Energy/Environment Research and Development Program. The overall project focuses on identifying and analyzing specific interrelationships between society's needs for energy, environmental quality, and agricultural production, and the impacts of alternative public policy strategies for dealing with these needs. This report is especially timely, because it follows the passage of major legislation in June 1980 that encourages large-scale development of a synthetic fuels industry, including synfuels based on coal. This legislation adds impetus to coal development, thereby placing additional rural resources at risk.

Acknowledgments

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This study is part of a continuing research project of ESS to assess the economic impacts of energy development. The project is being conducted in cooperation with the Office of Environmental Engineering and Technology, Office of Research and Development, U.S. Environmental Protection Agency (EPA), under agreement 79-D-X5019-EG. Paul Schwengels is the EPA project officer.

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Summary

Some rural lands and waters are at risk as America turns increasingly to developing its own vast coal reserves to decrease dependence on energy imports. In the eighties, far more coal will be mined, moved, and burned or converted to gas and liquid fuels, based on current expansion plans.

Generalizations about coal development are often unreliable or are valid only in specific geographic areas. For example, coal-related impacts, such as demands on water supplies or farmland disturbances from strip mining, may be only subregional or local.

The living conditions of some rural people may be adversely affected by coal development. However, coal development will generate more electricity nationwide and can stimulate more jobs and provide more tax revenues for some rural communities.

The impacts of coal development will vary in intensity and among geographical areas; they will be partly beneficial and partly adverse. Identifying and evaluating these locational impacts is a complex task for economic analysts. Before they can weigh either the benefits or the adverse impacts, they must know where, when, how, and how much coal is to be mined, moved, and used. This report describes the location and magnitude of coal reserves. It identifies the land, water, and human resources potentially involved in coal development, thus setting the stage for even more detailed analyses in future U.S. Department of Agriculture reports.

Relatively little farmland will likely be disturbed by the increased surface mining of coal, and any loss in agricultural production because of mining would not be serious nationally or regionally. Potential losses in farm income resulting from increased strip mining are estimated at $16 million annually for the six U.S. Coal Production Regions–less than 0.2 percent of the $11 billion farm income from these regions in 1979 (see fig.). The largest loss would be about $10 million annually in the Interior Region, where coal mines occupy land that is highly productive. In the Eastern Region, more land would be disturbed, but the value of agricultural production per acre is much lower and use patterns are less intensive; thus, the value of production lost would be about $4 million annually. In the Northern Great Plains and the Gulf Regions, the loss per region would be about $1 million annually.

However, in some areas current uses of water may be severely disturbed by coal development. Large quantities of water are required for cooling coal-fired electrical generating plants. Water is also used as a feedstock for coal gasification (converting coal to gas) and as a vehicle in slurry pipeline transportation of coal. Available supplies of water vary tremendously from one locality to another. In some coal-rich areas, such as the Tongue and Powder River Basins in Wyoming and Montana, and in the Colorado River Basin, surface water supplies are so scarce that added competition from coal development could become a serious problem. In other areas, such as most of the Eastern and Interior Regions, new coal development would use only a small portion of available surface water supplies.

Water quality is a major issue in coal development plans in any region. The question is not whether available supplies are of the right quality for coal development, but how such development will affect water quality for other uses. Water can be adversely affected in two ways: One is pollution from the mining operations, primarily acid mine drainage, and the other is thermal pollution from coal processing plants. Therefore, energy conversion plans must consider the problems of abating both air and water pollution.

Although some large cities are located on or near the edges of major coal producing areas, most counties in these areas are nonmetropolitan. Coal mining, although a major occupation in some local areas, represents only a small part of the total employment from a regional or national viewpoint. Most areas of new and rapidly expanding coal mining activity have a low population base and a relatively small work force. Thus, the socioeconomic impact of coal development on these areas may be far more severe than in those where mining is already well established.

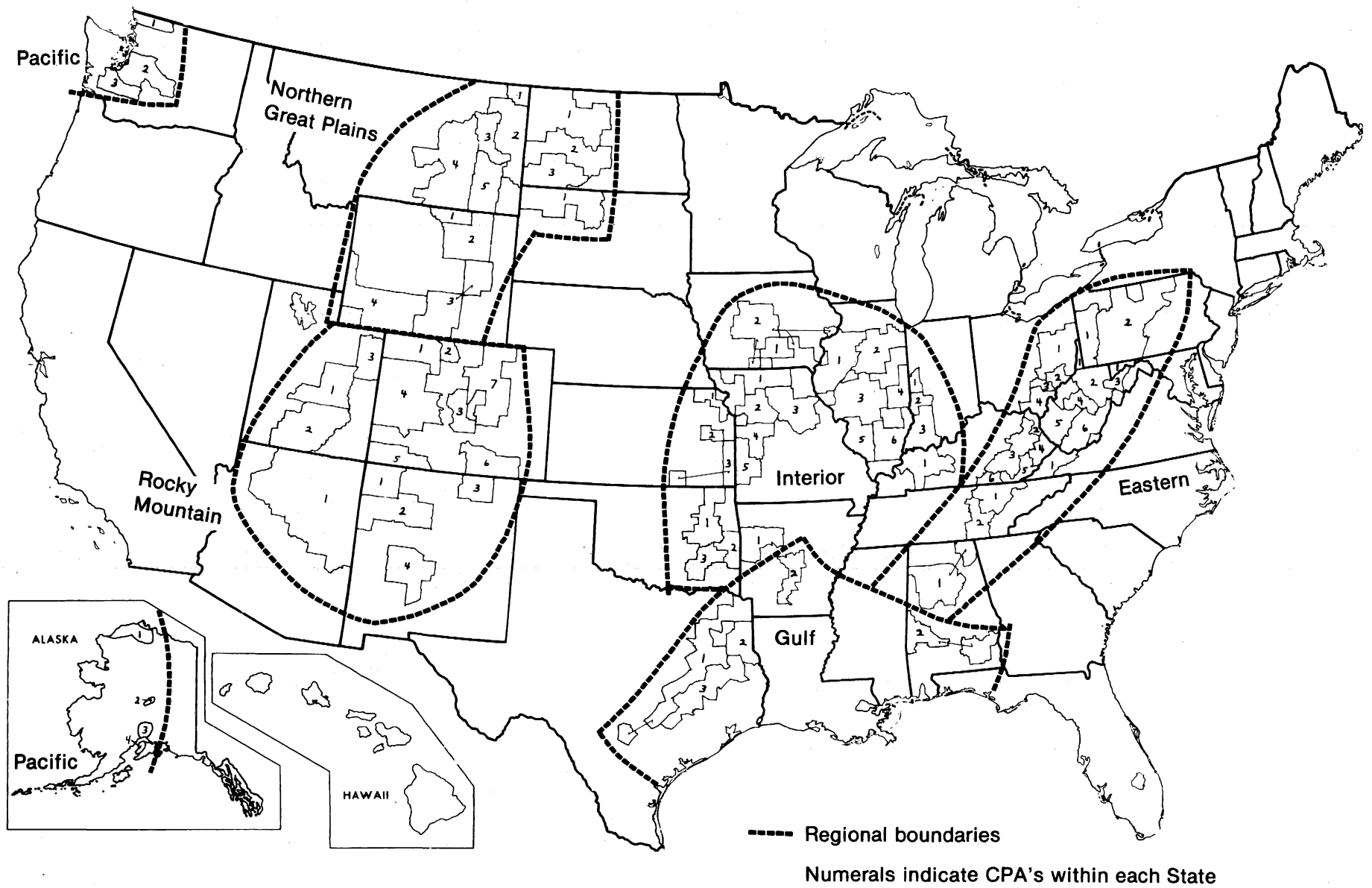
U.S. coal reserves are huge–about 437 billion tons. At the 1979 rate of production (estimated at 770 million tons) these reserves would last more than 500 years (see table). Coal reserves are concentrated mainly in three regions; the Northern Great Plains has 42 percent of the total, and the Interior and Eastern Regions have 24 percent each. There are, however, significant differences in quality. The cleanest coals, as measured by sulfur content, are in the western regions, while the coals with the highest heat content are in the Eastern and Rocky Mountain Regions.

An increasing share of U.S. coal production has come from the West in recent years. Based on announced plans of U.S. coal mining companies (always subject to change), the Northern Great Plains could increase its share further, from 15 percent of U.S. production in 1979 to over 30 percent by 1989; and the Rocky Mountain Region, from 7 percent to over 10 percent. At the same time, the Eastern share could drop from 54 percent to under 40 percent; and the Interior share, from 19 percent to under 15 percent.

In the Northern Great Plains, the coal is mostly subbituminous (soft); more than half is low in sulfur content, and it is found in very thick seams. About 60 percent of these coal reserves are owned by the Federal Government; the rest is

Figure 1

Coal Production Areas (CPA'S)



Characteristics of coal development, by Coal Production Region

Item	Unit	Northern Great Plains	Rocky Mountain	Interior	Eastern	Gulf	Pacific
Reserves	Bil. tons	178	24	105	105	4	14
	Pct. of U.S. total	42	6	24	24	1	3
Sulfur content[1]	Pct.	59 low	75 low	2 low	26 low	7 low	81 low
	do.	41 med	25 med	21 med	56 med	93 med	19 med
				77 high	18 high		
Coal ownership	do.	60 Federal	75 Federal	All private	Nearly all private	All private	[2]
Production, 1979	mty.[3]	118	52	144	423	27	6
	Pct. of U.S. total	15	7	19	54	3	1
Potential new capacity by 1987[4]	mty.	331	112	55	87	58	1
Potential production in 1987[5]	do.	449	164	199	510	85	7
	Pct. of U.S. total	32	12	14	36	6	*
Farm production displaced annually	1,000 dollars	939	185	9,762	4,212	995	35
Counties:							
Metro[6]	No.	0	6	41	35	7	2
Nonmetro	do.	47	35	159	136	44	4

* = Less than 0.5 percent.

[1] low = 0.063 or below (1971-77 "Compliance Coal"); med = more than 0.063 and less than 0.316; high = 0.316 or more. Ratio equals sulfur ÷ 10^3 Btu per pound.

[2] Coal is mostly private in Washington. In Alaska coal is either Federal, State, or tribal; the proportion of each is undetermined.

[3] mty = million tons per year.

[4] Planned increases in capacity of existing mines plus capacity of new mines.

[5] New capacity plus 1979 production. No allowance made for mines which may reduce or discontinue production at some future date.

[6] Metro counties are those included in Standard Metropolitan Statistical Areas (SMSA).

owned by States, Indian tribes, or private owners. Although actual production in the Northern Great Plains in 1979 was only 15 percent of the Nation's total, over 300 million more tons could be produced annually in the eighties. Nearly all the increase will likely be by surface mining. If achieved, this would result in a total production of nearly 450 million tons per year (mty) by about 1987.

The Eastern and Interior Regions each contain roughly 105 billion tons of coal, or 24 percent of the national total. The Eastern Region, however, far exceeds all others in current production with 54 percent. Eastern reserves are mainly bituminous; about one-fourth are low in sulfur, and the seams are thin compared with those for western coal. Nearly all the Eastern Region's coal rights are owned by private individuals or corporations. Future expansion possibilities for coal output are moderate, especially when compared with current production, and most of the new capacity will be in deep mines. Total production could reach 510 mty if all expansion plans were realized.

The Interior Region's coal is all bituminous, and three-fourths of the reserves are high in sulfur content. The average coal seams are thinner than in any other region. Virtually all coal rights are privately owned. The Interior is second among the regions in production but fifth in potential expansion, mostly through underground mining.

The Rocky Mountain Region has 6 percent of the Nation's coal reserves and produces 7 percent of the total U.S. coal output. Most reserves are low in sulfur and the seams are relatively thick. Most reserves in Arizona and New Mexico

are owned by Indian tribes. Of the remaining reserves, about 75 percent are federally owned. Potential exists for tripling the annual production by the late eighties, from 52 million to over 160 million tons.

Most coal reserves in the Gulf Region are in Texas, and these consist almost entirely of lignite. More than 90 percent is medium in sulfur content; the rest is low in sulfur. All reserves are privately owned; all production is from surface mines. Planned expansion will be more than three times current production.

Known coal reserves in the Pacific Region are mostly subbituminous, low in sulfur content, and found in relatively thick seams. However, the region consists of two dissimilar areas—relatively small coalfields in Washington and potentially large ones in Alaska, some of which are still unexplored. Not much expansion is expected in Alaska because local demand is likely to be small, and the distance to out-of-State markets is great.

Glossary

AR	As received (from the mine)
ASA	Aggregated subareas
bbl	Barrel
BLM	U.S. Bureau of Land Management
BOM	U.S. Bureau of Mines
Btu	British thermal unit
CAA	Clean Air Act
CPA	Coal Production Area (groups of coal production counties)
CPR	Coal Production Region (groups of CPA's)
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
ESS	Economics and Statistics Service
FGD	Flue gas desulfurization
KRCRA	Known recoverable coal resource areas
maf	Million acre-feet per year
metro	Metropolitan
MMcfd	Million cubic feet per day
Mty	Million tons per year
MW	Megawatt (1,000 kilowatts or 1 million watts)
NEP	National Energy Plan, 1977
NGP	Northern Great Plains Region
NGPRP	Northern Great Plains Resource Program (U.S. Department of the Interior)
nonmetro	Nonmetropolitan
NSPS	New Source Performance Standards
OPEC	Organization of Petroleum Exporting Countries
OSM	U.S. Office of Surface Mining
RM	Rocky Mountain Region
SIP	State Implementation Plans
SO_2	Sulfur dioxide
SMSA	Standard Metropolitan Statistical Area
TVA	Tennessee Valley Authority
USGS	U.S. Geological Survey

Coal Development in Rural America: The Resources at Risk

Wallace McMartin, Virgil Whetzel, and Paul R. Myers*

Introduction

Coal is an important part of the solution to our Nation's energy problem. But the mining, transportation, and burning of coal can harm the environment. Moreover, rapid development of coal mining operations and huge coal-burning electric power plants also bring problems of major social and economic change, of natural resource management, and of competition for some of these resources between new and traditional activities, such as agricultural production. In this report, we analyze those natural and human resources that will be most affected by the development of our massive coal reserves.

Energy Problems, Resources, and the Environment

Coal development has been influenced to a significant degree by policies and programs to reduce environmental damage. For example, Federal standards established in the seventies regulate sulfur dioxide emissions from fossil fuel combustion to reduce degradation of air quality. One way to meet these emission standards is to burn very low sulfur coal. Because the Nation's reserves vary widely in sulfur content and in other characteristics from region to region, the rate of coal mining and use in any area will depend significantly on relative costs of alternative technologies for sulfur dioxide control.

The cost of burning local, high-sulfur coal and removing the sulfur from power plant emissions must be weighed against the cost of burning lower sulfur coal. Most low-sulfur coal reserves are in the West; therefore, Eastern and Midwestern power plants can obtain this coal only at great transportation expense by bringing it 1,000 miles or more from the mine. In addition, enforcing the new standards for reclaiming surface-mined land will probably change cost-price relationships among coals of different areas and thus lead to a faster pace of coal development in some regions than in others.

Even at modest rates of expansion, the coal industry in any given area has some obvious problems. How can the industry maintain and increase its past rate of development while minimizing damage and maximizing benefits to the local area? Both public policymakers and managers of private enterprises have many options on how to proceed with coal development and at what pace. Some options are still open even though a substantial portion of total potential inputs, such as capital investment in mining, may have already been committed.

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Objectives of the Report

In this report, we describe the resource base in rural America that will be affected by future mining, transportation, and use of coal. These resources–land, water, vegetation, people, and farm or ranch enterprises–will be affected, for better or worse, by further development of the Nation's massive coal reserves.

However, we do not analyze systematically the likely impacts of coal development on these resources. Future impacts depend very much on projections of the kinds and extent of coal development that may occur. Therefore, in this "situation report," we describe the resource base itself as a prerequisite for any subsequent impact analysis. Projecting coal development alternatives and impact patterns is reserved for future reports, especially those resulting from runs of the Interregional Coal Analysis Model (*24*).[1]

Integrated Assessment and the ESS Project

What are some of the major options for expanding coal mining and use? What are some of the likely alternative patterns for coal development? Previous reports have addressed these questions and laid important groundwork (*11, 12, 16, 49, 51, 55, 69, 75, 104*). However, a more comprehensive analytical system is needed. Any analysis of these options and their impacts should assess alternative systems of coal development and evaluate interregional tradeoffs attributable to these alternatives. The Economics and Statistics Service (ESS) of the U.S. Department of Agriculture (USDA) has undertaken a comprehensive analysis in its project, "Integrated Assessment: Economic and Social Consequences of Coal and Oil Shale Development," conducted in cooperation with the Environmental Protection Agency (EPA).[2]

This research is scheduled to continue through 1984, with the objective of constructing an interregional analytical system based on a large-scale linear programming model. The model is designed to simulate the economic and environmental impact of changes in national demand for coal on the regional patterns of U.S. coal mining (*24*).

Methodology: Coal Production Areas

Despite the descriptive nature of this report, a key analytical concept is introduced–that of Coal Production Regions

[1] Italicized numbers in parentheses refer to references listed at the end of this report.

[2] A complete list of the acronyms and abbreviations used in this report appears in the glossary.

(CPR's) and Coal Production Areas (CPA's). This is basically a method of classifying data on a regional and subregional basis to facilitate assessing impacts of alternative development patterns upon relatively small areas.

In addition to small-area data, regional aggregate information is also useful. Defining basic geographic units for this report, the CPR's and CPA's, permits the economic model to aggregate and later to disaggregate data back down to the smallest geographic unit. In other words, the CPA is the basic geographic building block for the analytical system, and the CPR is an intermediate block.

After considerable study of the data available, the research team decided counties, or groups of similar counties, should be used to define the boundary lines of CPA's. At times, they used site-specific information, but site-by-site data were not always available, uniform, or appropriate to the issue at hand. As a geographic unit for organizing and aggregating basic data, the county is the best compromise between specificity and generality.

However, when a topic or issue warrants, we assembled data by areas unrelated to county lines, such as river basins or electric demand regions. We acknowledge that effects of coal development, such as electric transmission lines or commercial development, often extend well beyond coal production counties. However, using the CPA concept does not inhibit analysis of wider geographic effects.

Counties with similar coal characteristics are grouped into CPA's if they contain coal in commercial or potentially commercial quantities. Some CPA's may consist of only one county, but most contain more than one, and in no case does a CPA boundary cross a State boundary. Counties having no known significant amount of coal are not included in CPA's. Characteristics considered were rank of coal, average heat content, average sulfur content, and mining method most likely to be employed—that is, surface or underground (*79*). Generally counties with less than 10 million tons of reserves were omitted. The basis for county selection was two 1975 reports of the U.S. Bureau of Mines (*26, 74*). In a few cases more recent data suggest that certain other counties might have been included, but complete information was not available until the study was well underway.

We define six CPR's: the Northern Great Plains, Rocky Mountain, Interior, Eastern, Gulf, and Pacific Regions. In three cases the regions divide States; Kentucky is divided between the Interior and Eastern, Alabama is divided between the Eastern and Gulf, and Arkansas is divided between the Interior and Gulf Regions (fig. 1, see p. iv). From the CPR's, 86 CPA's were established, consisting of an aggregate of 516 counties with a total land area of 329 million acres (table 1).[3] Each CPA is identified by a symbol consisting of a two-letter abbreviation for the State, then a dash, then a numeral, for example, KY-4, KY-5, PA-1. No CPA includes counties in more than one State. Appendix table 1 shows a complete listing of the counties in each CPA.[4]

Coal

U.S. coal reserves total about 437 billion tons—enough for 500 years or more at the current rate of production. The Northern Great Plains has 42 percent of these reserves, while the Interior and Eastern Regions have 24 percent each. The cleanest coals, as measured by sulfur content, are in the West, but the coals with the highest heat content are found in the East and Rocky Mountains. In recent years, a larger and larger share of coal production has been coming from the West.

Resources and Reserves

Although estimates conflict on the amount of coal which exists in the United States, there is general agreement that coal reserves are abundant. According to the U.S. Geological Survey (USGS), the identified coal resources of the United States are about 1.7 trillion tons. In addition to identified resources, 2.2 trillion tons are classified as hypothetical resources, which brings the total to nearly 4 trillion tons (*3*). However, a more realistic estimate is one which includes coal that can be recovered under present economic and technological conditions—that is, the demonstrated coal reserve base.[5] The U.S. Bureau of Mines (BOM) estimates that the U.S. reserve base totaled about 437 billion tons, in 1974 (*26, 74*). Preliminary estimates for 1979 production are about 770 million tons, and if this rate were maintained indefinitely, the coal reserves would last 568 years.[6]

As many variables affect the ability of a given coal seam to qualify as a reserve, sufficiently precise and detailed data are

[3] Not counting Alaska, where there are no counties. The four Alaska CPA's occupy parts of six Census districts, each of which is much larger in area than any of the counties in most other States.

[4] Appendix tables begin on p. 55.

[5] The terms coal "resources" and coal "reserves," which must be distinguished, are used here as defined by the U.S. Geological Survey and the U.S. Bureau of Mines (*3, 26*). In general, the term "resources" means the total quantity of coal in the ground within a certain depth and within a specified limit of coalbed thickness. By contrast, the terms "reserves" or "reserve base," which are much more restrictive, denote only some of the "demonstrated resources," and of these, only those legally and economically minable with current technology and equipment. Even though a deposit is classified as a "reserve," it is not necessarily attractive for near term development. A deposit may be reclassified from "resource" to "reserve" if both economic factors and extraction technology improve.

[6] This figure merely indicates the size of the reserves and is not a forecast.

Table 1–Counties and land area included in Coal Production Areas (CPA's)

Region and State	CPA's	Counties	Land area of CPA's[1]
	Number		*1,000 acres*
Northern Great Plains:			
Montana	5	15	25,485
North Dakota	3	21	20,462
South Dakota	1	4	6,632
Wyoming	4	7	24,424
Total	13	47	77,003
Rocky Mountain:			
Arizona	1	3	25,357
Colorado	7	26	34,064
New Mexico	4	5	16,023
Utah	3	7	15,283
Total	15	41	90,728
Interior:			
Arkansas (NW part)	1	7	3,095
Illinois	6	68	24,525
Indiana	3	19	4,902
Iowa	2	26	9,007
Kansas	3	11	4,497
Kentucky (W part)	1	14	3,823
Missouri	5	39	15,332
Oklahoma	3	16	7,833
Total	24	200	73,014
Eastern:			
Alabama (N part)	1	12	6,337
Kentucky (E part)	5	33	7,561
Maryland	1	2	696
Ohio	4	26	8,066
Pennsylvania	2	29	14,831
Tennessee	2	19	5,045
Virginia	1	7	2,072
West Virginia	6	43	12,336
Total	22	171	56,943
Gulf:			
Alabama (S part)	1	9	4,552
Arkansas (SE part)	1	5	2,257
Texas	3	37	17,667
Total	5	51	24,476
Pacific:			
Alaska	4	*	*
Washington	3	6	7,286
Total	7	6	7,286
Total, all regions	86	516	329,450

* = No meaningful figure.
[1] Compiled from (*84*).

not available at the national level. However, despite deficiencies in the BOM reserve estimates, the data are useful insofar as they indicate the magnitude and relative distribution of coal reserves. From the available data one general conclusion is obvious–the United States has an abundance of coal, and no one now living is likely to see a coal shortage in this country.

Of the total U.S. coal reserves, the largest proportion, 40 percent, is located in the Northern Great Plains (table 2). The Interior and Eastern Regions each have about 24 percent of total reserves, and the Rocky Mountain, Pacific, and Gulf Regions have 5, 3, and 1 percent, respectively (*26, 74*).

These comparisons are made without adjustments for differing heat values among coals. For accurate comparisons of coal reserves among regions, or comparisons of different coals in the same region, the units of measure should be common, and for this report we use the British thermal unit (Btu). The average heat value per ton of coal in the United States is approximately 22.6 million Btu's per ton, ranging from 14.6 million Btu's per ton in the Gulf Region to 26.3 million Btu's per ton in the Eastern Region (*26, 68, 74*).

When the tonnages of all U.S. coal are adjusted to a "standard Btu coal" basis, the estimate for the proportion of coal reserves in each region changes.[7] The greatest changes occur in the Northern Great Plains and Eastern Regions. In the former, the estimate decreases from 40 to less than 36 percent, and in the Eastern Region, it increases from 24 to more than 28 percent of total reserves on a standard basis. In the Rocky Mountain and Interior Regions, the increase is less than 1 percent, and in the Gulf and Pacific Regions, the decrease is less than 1 percent.

Strippable and Deep-Minable Reserves.[8] U.S. coal reserves vary in rank among and within regions.[9] The 233 billion tons of bituminous coal reserves form the predominant rank, accounting for 53 percent of total (table 3). The remaining reserves consist of 168 billion tons of subbituminous (38

[7] A "standard Btu coal" is defined in this report as coal which yields 22.6 million Btu per ton. Therefore, a quantity of any other coal of a nonstandard Btu value per ton, yielding a certain total heat value for that tonnage, can be adjusted to a standard Btu coal tonnage yielding an equivalent total heat value. The adjusted quantity is called a "standard equivalent."

[8] For convenience, in this report the terms "strip" and "strippable" are used synonymously with the more general term "surface" or "surface minable."

[9] Rank is assigned to a coal according to its percentage of fixed carbon, the main determinant of its heat value. In general, the higher the percentage of fixed carbon, the higher the value. However, the rank is calculated on a mineral-matter-free basis. Minerals and ash content are used to calculate a coal grade (quality) with a rank; in general, the greater the mineral and ash content, the lower the quality.

percent), 28 billion tons of lignite (6 percent), and 7 billion tons of anthracite (2 percent). Unadjusted for heat value differences, about 69 percent of total U.S. reserves were classified by the BOM as accessible only by underground mining and 31 percent by surface mining (*26, 68, 74*). All but a small amount—about 3 percent—of these reserves are located in the 86 CPA's (as previously defined).

Two regions, the Northern Great Plains and Pacific, have bituminous, subbituminous, and lignite reserves. Subbituminous coal is the predominant rank in both regions. The Northern Great Plains accounts for 88 percent of all U.S. subbituminous reserves, most of which are located in MT-4, MT-5, and WY-2 (*79*). The Northern Great Plains also has about 86 percent of the total lignite reserves, most of which are located in North Dakota and eastern Montana. The Interior and Eastern Regions contain primarily bituminous reserves and together account for 90 percent of total reserves in this rank. Reserves tend to be concentrated in a few CPA's; for example, IL-3 has 22 billion tons, IL-6 has 17 billion tons, OH-1 has 15 billion tons, and four CPA's (PA-1, KY-1, WV-2, and WV-5) each have more than 12 billion tons. The Rocky Mountain Region has both bituminous and subbituminous coal and accounts for 7 and 5 percent, respectively, of total reserves in these ranks. The Gulf Region has lignite reserves only, which account for 15 percent of total lignite reserves (*26, 68, 74*).

Except for the Gulf Region, which has strippable reserves only, all regions have both deep-minable and strippable reserves. In the Pacific Region, the majority of the coal reserves, 58 percent, are surface minable. In the Northern Great Plains, deep-minable and strippable reserves are nearly equal, with 53 percent deep-minable and 47 percent strippable. In the remaining regions, however, deep-minable reserves prevail and account for 84, 73, and 86 percent of total reserves for the Rocky Mountain, Interior, and Eastern Regions, respectively.

Sulfur Content. Sulfur content is a key factor in determining coal quality, especially regarding Federal air quality standards. If sulfur content is low enough, a coal, when burned, will meet the 1971-77 Clean Air Act sulfur dioxide emission

Table 2—Coal reserves by region, 1974

Region	Quantity		Percentage of U.S. total		Heat value[2]		Standardization factor[4]	Contents per quantity unit			
										Sulfur	
	A.R.[2]	Standard coal equivalent	A.R.[2]	Standard coal equivalent[3]	Per pound	Per ton		Moisture[2]	Ash[3]	A.R.[2]	Standard coal equivalent[5]
	Million tons		*Percent*		*Btu's*	*Million Btu's*	*Units*	*Percent*			
Northern Great Plains	175,198	153,682	40.1	35.5	9,910	19.8	1.14	17.5	7.7	0.8	0.91
Rocky Mountain	23,592	25,925	5.4	6.0	12,400	24.8	.91	9.8	7.8	.5	.46
Interior	104,683	105,740	24.0	24.4	11,390	22.8	.99	9.9	10.6	3.1	3.07
Eastern	104,966	122,053	24.0	28.2	13,130	26.3	.86	3.9	8.8	1.7	1.16
Gulf	4,242	2,728	1.0	.6	7,310	14.6	1.55	31.5	9.2	1.2	1.86
Pacific	13,598	11,622	3.1	2.7	9,630	19.3	1.17	17.0	10.1	.2	0.23
Other[6]	10,472	11,636	2.4	2.7	12,550	25.1	.90	NA	NA	NA	NA
Total or average	436,751	433,385	100.0	100.0	11,300	22.6	1.00	11.8	8.8	1.6	1.60

NA = Not available.

[1] Percentage of each region's total.

[2] A.R. = Analysis on an as received basis; there has been no beneficiation.

[3] Adjusted to a standard 22.6 million Btu/ton.

[4] The standardization factor indicates the number of tons of nonstandard Btu coal necessary to produce the same Btu value produced from 1 ton of standard Btu coal.

[5] Percentage of sulfur on a standard coal equivalent basis—that is, adjusted to Btu value of the coal.

[6] Coal not in the designated CPA's; includes 7.257 billion tons in the Eastern Region (all anthracite), 2.968 billion tons in the Rocky Mountain Region (bituminous and subbituminous), and 123 million tons in the other regions.

Sources: (*26, 44, 74, 106*).

Table 3–Coal reserves, by region, rank, and mining method

Region	Bituminous			Subbituminous		
	Deep	Strip	Total	Deep	Strip	Total
	Million tons					
Northern Great Plains	5,908	0	5,908	[1] 89,416	59,310	148,726
Rocky Mountain	14,534	1,382	15,916	5,352	2,358	7,710
Interior	81,234	23,449	104,683	0	0	0
Eastern	90,258	14,709	104,967	0	0	0
Gulf	0	0	0	0	0	0
Pacific	251	1,201	1,452	5,440	6,402	11,842
United States	192,185	40,741	232,926	100,208	68,070	168,278

	Lignite			Total		
	Deep	Strip	Total	Deep	Strip	Total
	Million tons					
Northern Great Plains	0	23,529	23,529	[1] 95,324	82,839	178,163
Rocky Mountain	0	0	0	19,886	3,740	23,626
Interior	0	0	0	81,234	23,449	104,683
Eastern	0	0	0	90,258	14,709	104,967
Gulf	0	4,331	4,331	0	4,331	4,331
Pacific	0	304	304	5,691	7,907	13,598
United States	0	28,164	28,164	292,393	136,975	429,368

[1] Includes 2,968 million tons not part of designated CPA's.

Source: (*26, 107*).

standards without use of scrubbers to desulfurize flue gases (but not the standards in effect for 1978 and beyond).[10]

Coal containing 0.6 pound or less of sulfur per million Btu will meet the 1971-77 emission standards. In this report, it is defined as "SO_2 compliance coal."[11]

As many existing electric utility steam-generating units are governed by the 1971-77 New Source Performance Standards (NSPS), burning low sulfur compliance coal is a major alternative to installing "stack gas scrubbers" (equipment to clean gasses emitted by plants burning coal). Therefore, it is important to know how much of each region's coal reserves can be classified as SO_2 compliance coal.

[10] Sulfur in coal burned by electric power plants contributes to equipment corrosion and the formation of boiler deposits. Sulfur oxides as combustion products emitted to the atmosphere can injure many forms of life, including humans, crops, and forests. In recognition of these effects, the Clean Air Act (CAA) limits sulfur dioxide in the atmosphere and sulfur dioxide from certain emissions through its provisions for (1) air quality and standards to be achieved by "State implementation plans" (SIP) and (2) New Source Performance Standards (NSPS) for new electric generating plants and other new facilities constructed since 1971. The NSPS, in effect from 1971 through 1977, required that no more than 1.2 pounds of sulfur dioxide be emitted per million Btu of fuel burned. Sulfur dioxide is formed at that approximate rate during normal combustion of coal containing 0.6 pound of sulfur per million Btu. Therefore, at this rate of sulfur dioxide formation, no more than 0.6 pound of sulfur per million Btu can be present (to comply with NSPS) in a fuel intended for combustion without the use of flue gas desulfurization equipment (stack gas scrubbers). Thus, for a standard Btu coal containing 22.6 million Btu per ton, the *defacto* upper limit is 14 pounds of sulfur per ton or 0.7 percent sulfur, if the coal is to yield sulfur dioxide emissions (without scrubbers) no greater than the legal limit for 1971-77 "new sources." NSPS mandated by the 1977 Clean Air Act amendments prescribe the best available control technology, generally interpreted as stack gas scrubbers. Nevertheless, sulfur content is still an important consideration as scrubbers are not required for 1971-77 new sources and as coal sulfur content affects scrubber operations. In general, the lower the coal sulfur content, the easier the scrubber operation and the better the potential for removing a high percentage of a coal's sulfur content.

[11] The concept of "compliance coal" is well established. The term is used in the coal trade and refers to likely compliance with SO_2 NSPS. The concept is also used by the BOM in a recent report on coal sulfur content (*11*).

Researchers at Argonne National Laboratory have estimated the amount of NSPS coal available, on a county basis, by using the following formula:

pounds SO_2 emitted/ton coal fired = 38 S

where 38 is a constant and S is the percentage of sulfur in coal (for coal containing 2 percent sulfur, S = 2). If the heating value of coal is H (in 10^3 Btu/lb.), then a generating unit meeting NSPS must have:

lb. SO_2 emitted/10^6 Btu = 38S (lb. SO_2 emitted/ton coal fired)
X (1/2000) (ton/lb.)
X 1/H (lb. of coal/10^3 Btu)
= 1.2 (lb. SO_2/10^6 Btu) (NSPS limit)
(S/H) = 0.632 for NSPS

As an example, with 12,000 Btu/lb. (H = 12), the sulfur content must be 0.76 percent (= .0632 X 12) or less to meet NSPS (*71*).

About 164 billion tons, or about 38 percent, of the U.S. total reserves are estimated to be SO_2 compliance coal (table 4). All six regions have some compliance coal; the largest absolute amount, 105 billion tons, is in the Northern Great Plains. Of each region's total reserves, the proportionate amount of compliance coal ranges from a high of 81 percent in the Pacific Region down to about 2 percent in the Interior Region.

The 1971-77 sulfur dioxide emission standards required attainment of an emission level not to exceed 1.2 pounds of SO_2 per million Btu for compliance. Current regulations impose much more definitive scrubbing (sulfur removal) requirements.[12] Under the new regulations, plants firing high sulfur coals (those which in an as-mined state would emit greater than 6.0 pounds of SO_2 per million Btu) must remove 90 percent of the SO_2. For coals which in their as-mined state would emit between 2.0 and 6.0 pounds of SO_2 per million Btu, a sliding scale of SO_2 removal between 70 and 90 percent applies. The maximum emission limit is 0.6 pound SO_2 per million Btu (*31, 120*).

Figure 2 shows the SO_2 removal requirements for coals with various heat values and sulfur contents. Any point on the x-y axis may be defined by the following formulas:

[12]The current, new stationary sources performance standards for electric-utility steam-generating units became effective June 11, 1979. They apply to units capable of firing more than 73 MW (heat input of fossil fuel) for which construction began after September 18, 1978 (*119*).

1. lbs. of SO_2 emitted/10^6 Btu = $2\left[\frac{2{,}000 \text{ lb./ton S \% S}}{\text{Btu/ton}}\right]$

2. Flue gas desulfurization (FGD) required to meet standard =

$$\left[1 - \frac{\text{required emission standard}}{\text{emission from coal prior to FGD}}\right] \Big/ \text{decimal operational efficiency of FGD system}$$

For example, given a 3-percent sulfur coal of 12,000 Btu per pound:

(24 X 10^6 Btu/ton)

lbs. SO_2 emitted/10^6 Btu = $2\left[\frac{2{,}000 \text{ X } 0.03}{24 \text{ X } 10^6}\right]$

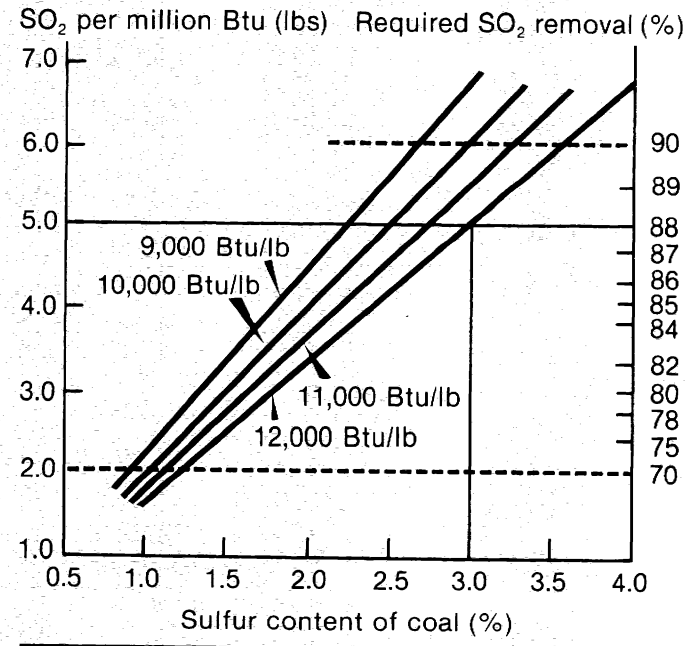
= 5 lbs. SO_2/10^6 Btu

and, assuming a 100-percent efficient FGD system:

$$\% \text{ FGD required} = 1 - \frac{1 - \frac{0.61}{5.0}}{1} = 1 - 0.12 = 0.88$$

Figure 2

SO_2 Removal Requirements under the 1978 New Source Performance Standards Applicable to Coal-Fired Utility Plants



In other words, 3-percent sulfur coal with 12,000 Btu per pound in its uncontrolled state would emit 5 pounds of SO_2 per 10^6 Btu and would require 88 percent FGD to meet the emission limit of 0.6 pound of SO_2 per 10^6 Btu (*31, 120*).

As previously mentioned, about 38 percent of total U.S. coal reserves was classified as compliance coal that required no scrubbing to meet 1971-77 NSPS. Under the new SO_2 emission regulations (1978), this same coal requires a 70-percent reduction in potential emissions. About 166 billion tons, or 39 percent, require emission reduction of between 70 and 90 percent (column 7 minus column 4 in table 4). The remaining 99 billion tons require a minimum of 90-percent reduction in potential emissions (column 8 minus column 7 in table 4).

The amount of 1971-77 NSPS compliance coal for each region equals the amount of coal which now requires the minimum of 70-percent reduction in emissions (column 4 in table 4). In three of the regions, Rocky Mountain, Gulf, and Pacific, none of the coal would require the maximum 90-percent emission reduction, and in the Northern Great Plains only an insignificant amount would require maximum reduction. The coals in these regions which would require between 70- and 90-percent emission reduction total about 73 billion tons in the Northern Great Plains, 6 billion tons in the Rocky Mountain, 4 billion tons in the Gulf, and 3 billion tons in the Pacific Regions. In the Interior and Eastern Regions, 22 billion and 59 billion tons, respectively, would require between 70- and 90-percent emission reduction. Both these regions have considerable coal that would require maximum (90 percent) emission reduction. In the Interior, 80 billion tons, or 77 percent of total reserves, would require maximum emission reduction. In the Eastern Region, maximum emission reduction is required for 19 billion tons, or 18 percent of total reserves (column 8 in table 4).

The preceding estimates of sulfur content are linked to the statistical distribution of the demonstrated reserve base. However, the form in which the sulfur occurs is not considered.[13]

[13] Sulfur occurs in coal in organic and pyritic forms. Organic sulfur, bonded in the coal, cannot be removed by mechanical washing, wheras some pyritic sulfur can be removed. As emission regulations allow the percentage reduction to be computed based on overall SO_2 removed by all types of SO_2 and sulfur removal technology, including washing, the form in which the sulfur occurs in the coal has some bearing upon its pretreatment potential (*11*).

Table 4—Coal reserves, by sulfur content to heating value ratio

Region	Ratio of sulfur content to heating value (percentage S/10^3 Btu/lb.)[1] of–							
	0.021	0.042	0.050	0.063[2]	0.100	0.210	0.246	⩾0.316[3]
	Million tons							
Northern Great Plains	0	95,777	98,996	105,192	164,476	177,744	177,927	178,104
Rocky Mountain	3,072	11,450	13,438	17,637	21,182	23,619	23,619	23,619
Interior	0	236	316	2,245	11,232	19,176	24,493	104,683
Eastern	5	9,097	15,105	27,397	39,604	74,590	86,057	104,966
Gulf	0	0	13	280	740	4,242	4,242	4,242
Pacific	0	4,447	9,083	11,071	13,369	13,598	13,598	13,598
United States	3,072	120,987	136,951	163,822	250,603	312,969	329,936	429,212
	Percent[4]							
Northern Great Plains	0	53.8	55.6	59.1	92.4	99.8	99.9	100.0
Rocky Mountain	13.0	48.5	56.9	74.7	89.7	100.0	100.0	100.0
Interior	0	.2	.3	2.1	10.7	18.3	23.4	100.0
Eastern	[5]	8.7	14.4	26.1	37.7	71.1	82.0	100.0
Gulf	0	0	.3	6.6	17.5	100.0	100.0	100.0
Pacific	0	32.7	66.8	81.4	98.3	100.0	100.0	100.0
United States	.7	28.2	31.9	38.2	58.4	72.9	76.9	100.0

[1] Entries indicate reserves with S/H ratios less than or equal to the value stated, and hence are cumulative in any row.
[2] Meets 1971-77 Federal New Source Performance Standards (NSPS) without flue gas desulfurization and meets 1979 NSPS for 70-percent emission reduction.
[3] Requires a 90-percent reduction in emissions for electric generating units constructed after September 18, 1978.
[4] Cumulative percentage.
[5] Less than 0.05 percent.

Source: (*71*).

Although these estimates may not be reliable to the degree desired for long-term energy planning, they indicate the gross availabilities and regional distribution of coals with various sulfur contents.

Reserve Characteristics and Mining Economics. The main factor affecting the economic feasibility of strip mining at any given site is the stripping ratio—that is, the thickness of overburden relative to the thickness of the economically recoverable coal seam or seams. The lower the stripping ratio, the better. Among U.S. regions, average maximum stripping ratios range from 3.5:1 in the Northern Great Plains to 17.7:1 in the Interior Region (table 5).

In many instances, the range in average stripping ratios within regions is greater than between regions. In the Northern Great Plains, average maximum stripping ratios range from 1.9:1 in Montana to 10.0:1 in South Dakota. In the Rocky Mountains, where the range in stripping ratios between States is relatively small, the range is from 6.8:1 in Utah to 8.2:1 in New Mexico. For the Interior Region, the range is from

Table 5—Surface mining coefficients for the United States, by region

Region	Seam thickness	Maximum overburden	Coal yield		Maximum stripping ratios[1]		
	Ft.		*Tons/ acre*[2]	*Std. tons/ acre*[3]	*Ft. overburden/ ft. coal*	*Cu. yds. overburden/ ton coal*	*Cu. yds. overburden/ std. ton coal*
Northern Great Plains:[4]							
Low	5.0	96	7,000	3,910	1.9	2.2	3.0
Average	34.0	118	47,870	33,010	3.5	4.0	5.8
High	64.0	125	90,480	65,380	20.0	23.1	41.3
Rocky Mountain:[4]							
Low	10.0	80	14,160	12,970	6.8	7.1	8.1
Average	12.0	91	16,280	16,120	7.6	9.0	9.1
High	14.0	105	19,930	19,560	8.2	9.5	11.6
Interior:[4]							
Low	2.0	30	2,880	2,590	15.0	16.8	16.7
Average	3.5	62	5,040	5,040	17.7	19.8	19.8
High	4.1	82	5,880	5,880	28.8	32.3	26.5
Eastern:[4]							
Low	2.1	43	3,000	3,570	14.0	15.6	13.5
Average	3.8	58	5,520	6,350	15.1	17.0	14.7
High	4.3	64	6,120	7,290	24.0	26.9	22.6
Gulf:[4]							
Low[5]	3.4	90	4,760	2,380	12.3	14.2	19.6
Average[4]	6.7	93	9,380	6,050	13.9	16.0	24.8
High[5]	7.3	100	10,220	7,410	29.4	33.9	67.8
Pacific:							
Low	–	–	–	–	–	–	–
Average	22.0	220	31,150	22,400	10.0	11.4	15.8
High	–	–	–	–	–	–	–

– = Not available.

[1] Maximum stripping ratios based on criteria used by U.S. Bureau of Mines in establishing reserves.

[2] Based on an 80-percent recovery rate with a yield of 1,440 tons bituminous, 1,416 tons subbituminous, and 1,400 tons lignite per acre foot.

[3] Adjusted to a standard 22.6 million Btu/ton.

[4] Indicates range and average of State averages within each region.

[5] Due to the variability of coal seam and overburden thickness and to the large area under consideration, averages are not available for Alaska. Data for the Pacific Region are for Washington only.

Sources: (*9, 14, 26, 44, 70, 72, 74, 106*).

15.0:1 in Kansas, Missouri, and Oklahoma to 28.8:1 in Arkansas. Stripping ratios in the Eastern Region range from 14.0:1 in eastern Kentucky to 24.0:1 in Alabama, and in the Gulf Region from 12.3:1 in Texas to 29.4:1 in Arkansas. Due to the variability of overburden and seam thickness in Alaska, no range was established for the Pacific Region; however, the average maximum stripping ratio for Washington is 10.0:1.

Another way to express these relationships is to measure the them in cubic yards of overburden per ton of coal. By this concept, the average ranges from 4.0 cubic yards of overburden per ton of coal in the Northern Great Plains to 19.8 cubic yards in the Interior. But on another basis—recoverable coal yield per acre of surface area above the coal—the Northern Great Plains is highest, averaging 47,870 tons of recoverable reserves, and the Interior is lowest, averaging 5,040 tons per acre (nonstandard coal). By comparison, coal yield averages 31,150 tons per acre for the Pacific (Washington), 16,280 tons for the Rocky Mountain, 9,380 tons for the Gulf, and 5,520 tons for the Eastern Regions.

When adjusted to a standard ton basis, coal yield per acre decreases to 33,010 tons for the Northern Great Plains, 16,120 tons for the Rocky Mountain, 22,400 tons for the Pacific, and 6,050 tons for the Gulf Regions. For the Eastern Region, recoverable reserves increase to 6,350 tons per acre. For the Interior Region, the yield per acre in standard tons is the same as "as received" tons.

The coal seams of the Northern Great Plains, Rocky Mountain, and Pacific Regions are generally much thicker than those of the Interior, Eastern, and Gulf Regions. Thus, recoverable strippable reserves per acre in the Northern Great Plains, for example, are nine times the reserves per acre in the Interior (seven times on a standard basis). When mining starts, the amount of recoverable reserves per acre is a major influence on both production of coal per acre and mining costs per ton.

The preceding material is based on criteria establishing average coal yields and maximum stripping ratios, but actual mining coefficients may not fall within the parameters set by these criteria. Other factors influencing coal yields include overburden characteristics, slope, and the number, depth, and character of the coal seams. Even so, average stripping ratios and coal yields are useful in comparing relative surface mining coefficients between regions.

Production and Utilization

Coal output attained a record high in 1979. Total production will probably continue to rise gradually, based on announced plans of coal companies to open new mines or expand existing ones. Although most coal is used to generate electricity, other uses, such as gasification or exports, could become increasingly important.

Historical Trends. U.S. coal production hit its lowest point for the past 60 years in 1932, when 309 million tons were produced (app. table 2). Production subsequently moved upward to peak at 631 million tons in 1947, then fluctuated sporadically, and did not reach the 600-million-ton mark again until 1970 (fig. 3). In 1971, output fell to 552 million tons and remained below 600 million tons until 1974, when it reached 603 million tons. By 1977, production had increased to a high of 691 million tons. However, because of an extended strike by the United Mine Workers, production in 1978 fell to 653 million tons (*103, 105*). Preliminary estimates for 1979 are about 770 million tons, a new record (*90*).

Historically, the Eastern and Interior Regions have been the major coal-producing areas of the United States. However, in recent years, as the demand has increased, especially for SO_2 compliance coal, mining activity in other regions has taken on new importance. During the 1970-78 period, coal production decreased from 418 million tons to 370 million tons in the Eastern Region, and from 149 million tons to 126 million tons in the Interior Region. During the same period, coal production increased from 16 million tons to 99 million tons in the Northern Great Plains, from 18 million tons to 45 million tons in the Rocky Mountain, from 0.6 million tons to over 5 million tons in the Pacific, and from near zero to 21 million tons in the Gulf Regions (*103, 105*). Preliminary data for 1979 show substantial increases over 1978 production in every region.

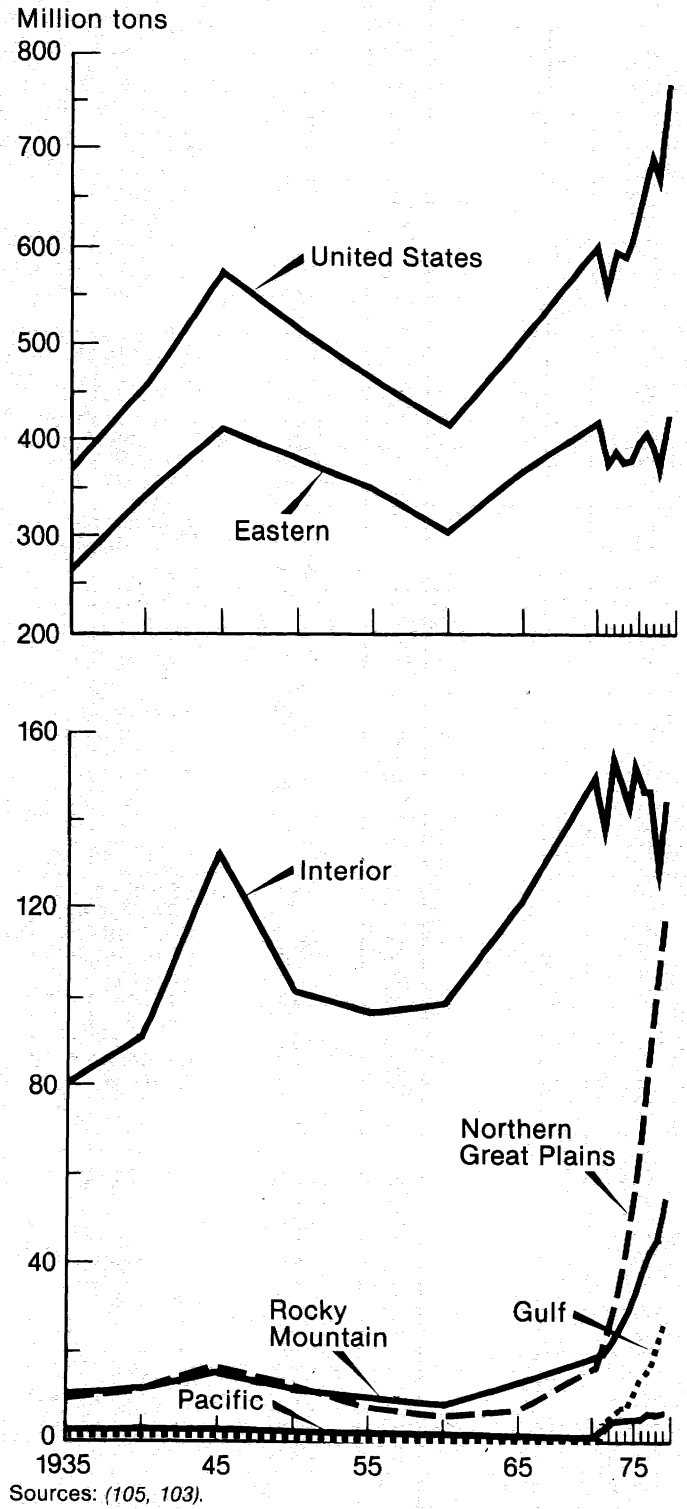
As a proportion of all U.S. production, the Eastern Region decreased from 69 percent to 55 percent, and the Interior from 25 percent to 19 percent in the 8 years from 1970 to 1978 (fig. 4). During the same period, the Northern Great Plains increased from 3 percent to 15 percent, the Rocky Mountain from 3 percent to 7 percent, the Gulf from 0 to 3 percent, and the Pacific from 0.1 percent to nearly 1 percent.

Within regions, a wide difference in production occurred among the CPA's. The leading CPA in production in 1978 was PA-2, with 58 million tons (app. table 3).[14] Three of the five highest producing CPA's were in the Eastern Region. KY-4 in the Eastern Region was second among the CPA's, with 41 million tons. The largest production of coal from deep mines came from KY-4 with 24 million tons and from WV-6 with 21 million tons. In production of strip-mined coal, PA-2 was first with 40 million tons, followed by WY-2 with 29 million and MT-4 with 26 million tons.

[14] The latest data available by CPA's are for 1978.

Figure 3

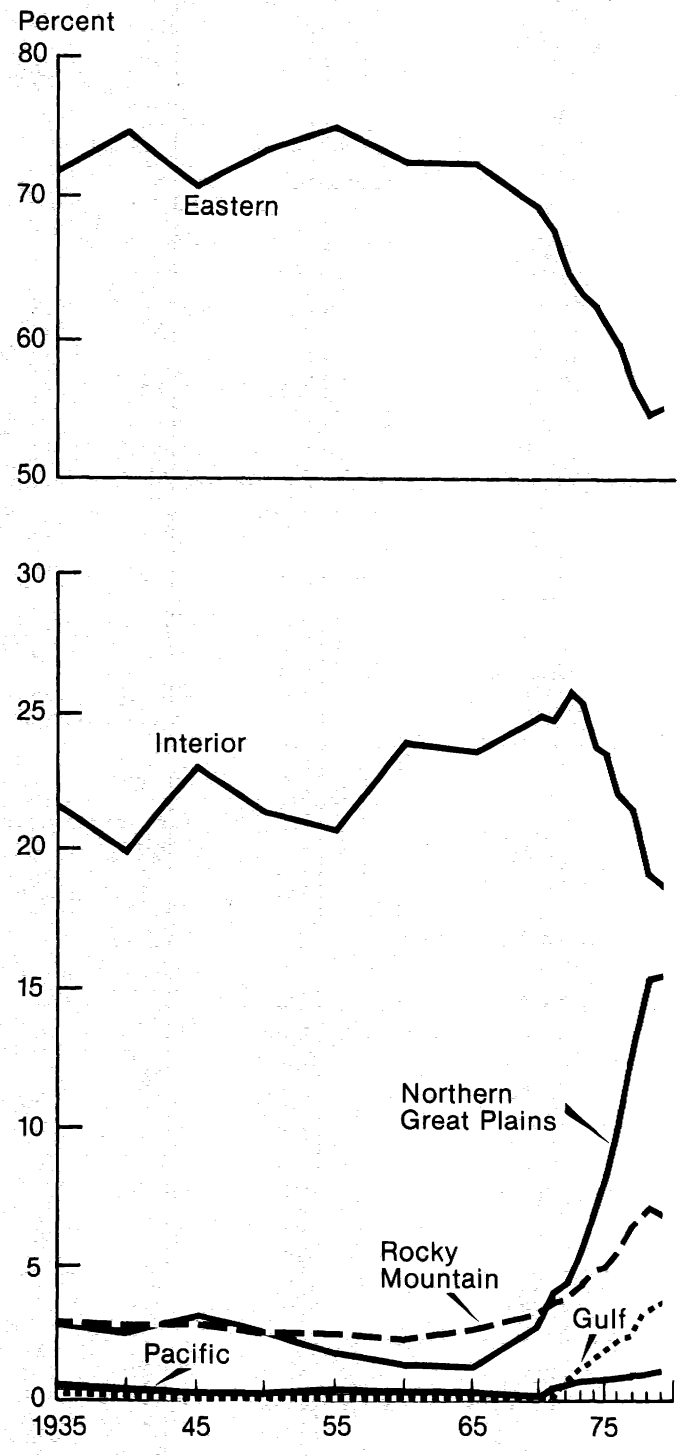
U.S. Coal Production by Region, Selected Years, 1935-79



Sources: *(105, 103)*.

Figure 4

Percentage of Total U.S. Coal Production, by Region, Selected Years, 1935-79



Gulf region data for 1945-71 is less than 0.05 percent.

Source: *(103)*.

As coal production has increased, the proportion extracted by surface mining has also risen, largely because of lower costs per ton, as explained later on. In 1940, surface mining accounted for less than 10 percent of total U.S. production, but by 1979, 61 percent came from surface mines. A similar trend has occurred in each region. For the Northern Great Plains, the proportion of coal extracted by surface mining increased from 25 percent in 1940 to 99 percent in 1979. During the same period, the increase was from less than 1 percent to 71 percent in the Rocky Mountain; from 33 to 63 percent in the Interior; from 3 to 45 percent in the Eastern; from 5 to 100 percent in the Gulf; and from 1 to 100 percent in the Pacific (*103, 105*).

Mine Size and Distribution. In 1978, 6,230 mines were operating in the United States. Of these, 2,502 were underground and 3,530 were surface. Most were small; about 96 percent produced less than 500,000 tons each. The remaining 4 percent accounted for about 50 percent (333 million tons) of total U.S. production (table 6) (*103*). By contrast, mines producing less than 10,000 tons each numbered 1,577 and accounted for only 1.1 percent (7.5 million tons) of total production.

The Eastern Region had the largest number of mines–5,593. However, 69 percent (or 3,833 mines) produced less than 50,000 tons, accounting for 18 percent of production in the region, while 106 mines produced over 500,000 tons each, accounting for 23 percent. In the Northern Great Plains the mines are larger; 27 of them produced more than 500,000 tons each and accounted for 97 percent of the coal mined in that region. The Rocky Mountain Region had 87 mines in 1978, of which 18 produced over 500,000 tons each, 76 percent of total production. Of the Interior Region's 455 mines, 93 produced over 500,000 tons each and accounted for 80 percent of total production. The Gulf Region had six mines, of which five were large (over 500,000 tons each); the Pacific Region had two large mines and one small one. Large mines accounted for more than 98 percent of total production in the two regions.

Projections and Future Plans. In the short run, coal production is limited to what can be produced from existing mines. In the long run, the coal industry can open new mines to increase production as needed. Bringing a new surface mine into production in the East may take from 1.5 to 3 years, including planning, construction time, equipment acquisition, environmental studies, permits, and other necessary requirements. It would take from 4 to 15 years to open a surface mine in the West. The time required to open a new underground mine may range from 2.5 to 5 years in the East and 3 to 13 years in the West.[15]

Projections of future production are difficult to make because so many unforeseeable events could influence future developments. However, because of the long leadtime required, the expansion plans of mining companies can indicate potential changes in production, and a number of projections have been made on this basis. Planned coal mine development, including new mines (either planned or in various stages of development), reopening old mines, and expanding existing mines, would add about 645 million tons of new U.S. coal mining capacity between 1979 and 1987 (table 7). This, however, may not increase net capacity because of closing or decreased production of existing mines (*7, 43, 44, 67, 92*).

The planned development or expansion includes a total of 406 mines–237 underground and 169 surface. About 41 percent (or 166 mines) are planned for the Eastern Region, with the majority (132 mines) being underground mines. Most new or expanding mines in the Rocky Mountain and Interior Regions are also underground. Of 92 mines in the Rocky Mountains, 65 will be underground, and in the Interior, 30 of 65 will be underground. In the Northern Great Plains, 64 of 69 are scheduled as surface mines, and for the Gulf and Pacific Regions, all new or expanding mines, 12 and 2, respectively, will be surface mines.

Although the Eastern Region plans the largest number of mines, total new mining capacity is greatest for the Northern Great Plains, where new or expanded mines could produce about 331 million tons, 51 percent of the total new capacity for the United States. The Rocky Mountain region ranks second in new capacity with 112 million tons, followed by: the Eastern Region, 87 million tons; the Gulf Region, 58 million tons; the Interior Region, 55 million tons; and the Pacific Region, 1 million tons. In the Northern Great Plains and Gulf Regions, the average planned capacity of new or expanded mines would be 4.8 million tons annually, whereas the average capacity in the Eastern and Interior Regions would be 0.5 and 0.8 million tons, respectively. Thus the number of new underground mines exceeds the number of surface mines, but most of the new capacity will be from strip mines, because of their greater average size.

[15] "The time span for the West relates primarily to environmental and other governmental considerations, which can account for a considerable portion of the time required"–quoted from (*57*). Most western mines involve leasing some Federal coal land, and the requirements for meeting environmental constraints are more time consuming.

Table 6–Number of mines and quantity of production, by region, size, and type of mine, 1978

Region and type of mine	500,000 tons and over		200,000-499,999 tons		100,000-199,999 tons		50,000-99,999 tons		10,000-49,999 tons		Less than 10,000 tons		Total[1]	
	Mines	Quantity	Mines	Quantity	Mines	Quantity	Mines	Quantity	Mines	Quantity	Mines	Quantity	Mines	Quantity
	No.	*1,000 tons*	*No.*	*1,000 tons*	*No.*	*1,000 tons*	*No.*	*1,000 tons*	*No.*	*1,000 tons*	*No.*	*1,000 tons*	*No.*	*1,000 tons*
Northern Great Plains:														
Underground	0	0	2	708	0	0	0	0	0	0	0	0	2	708
Surface	27	96,246	5	1,659	2	285	0	0	1	16	6	42	41	98,248
Total	27	96,246	7	2,367	2	285	0	0	1	16	6	42	43	98,956
Rocky Mountain:														
Underground	6	5,231	19	6,895	8	1,166	9	702	9	216	4	16	55	14,228
Surface	12	28,906	3	705	3	396	2	169	8	221	4	15	32	30,413
Total	18	34,137	22	7,600	11	1,562	11	871	17	438	8	31	87	44,641
Interior:														
Underground	37	37,570	12	4,546	7	896	3	228	4	108	5	18	68	43,366
Surface	43	53,435	44	13,686	46	6,661	73	5,310	128	3,252	93	459	427	82,803
Total	80	91,003	56	18,233	53	7,558	76	5,537	132	3,359	98	476	495	126,168
Eastern:														
Underground	70	54,031	140	44,310	208	29,558	347	24,526	1,069	28,069	741	3,380	2,575	183,874
Surface	36	32,244	149	43,391	258	36,144	552	37,659	1,300	32,929	723	3,545	3,018	185,915
Total	106	86,277	289	87,700	466	65,703	899	62,185	2,369	60,999	1,464	6,926	5,593	369,789
Gulf:														
Underground	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Surface	5	19,748	1	271	0	0	0	0	0	0	0	0	6	20,020
Total	5	19,748	1	271	0	0	0	0	0	0	0	0	6	20,020
Pacific:														
Underground	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Surface	2	5,425	0	0	0	0	0	0	1	14	0	0	3	5,439
Total	2	5,425	0	0	0	0	0	0	1	14	0	0	3	5,439
U.S. total:														
Underground	113	96,833	173	56,459	223	31,620	359	25,456	1,082	28,394	750	3,414	2,700	242,177
Surface[2]	125	236,004	202	59,713	309	43,486	628	43,227	1,439	36,453	827	4,067	3,530	422,950
Total[1 2]	238	332,838	375	116,172	532	75,106	987	68,683	2,521	64,847	1,577	7,481	6,230	665,127

[1] Data may not add to total because of rounding.
[2] Includes Georgia.

Source: (*103*).

Table 7—New coal mine development and expansion of existing mines, by region, 1979-87

Region and State	Number of mines			Production at full capacity			Present capacity[1]	New capacity[2]
	Deep	Strip	Total	Deep	Strip	Total		
				Million tons				
Northern Great Plains:								
Montana	1	11	12	1.00	88.80	89.80	31.80	58.00
North Dakota	1	13	14	4.00	41.44	45.44	10.25	35.19
Wyoming	3	40	43	7.25	285.95	293.20	55.20	238.00
Total	5	64	69	12.25	416.19	428.44	97.25	331.19
Rocky Mountain:								
Arizona	–	1	1	–	8.00	8.00	8.00	0
Colorado	33	10	43	31.64	12.30	43.94	9.60	34.34
New Mexico	1	15	16	1.00	63.40	64.40	18.50	45.90
Utah	31	1	32	43.95	1.00	44.95	13.17	31.78
Total	65	27	92	76.59	84.70	161.29	49.27	112.02
Interior:								
Illinois	22	9	31	42.20	13.20	55.40	21.25	34.15
Indiana	1	8	9	.50	17.60	18.10	9.20	8.90
Kansas	–	3	3	–	2.45	2.45	.42	2.03
Kentucky, West	10	4	14	13.90	3.80	17.70	9.40	8.30
Oklahoma	2	6	8	.75	2.40	3.15	1.20	1.95
Total	35	30	65	57.35	39.45	96.80	41.47	55.33
Eastern:								
Alabama	11	7	18	14.50	5.30	19.80	4.90	14.90
Kentucky, East	31	13	44	21.53	8.95	30.48	17.24	13.24
Maryland	1	–	1	1.80	–	1.80	.70	1.10
Ohio	10	3	13	20.60	3.16	23.76	10.75	13.01
Pennsylvania	19	5	24	19.45	3.51	22.96	11.55	11.41
Virginia	7	–	7	6.30	–	6.30	1.50	4.80
West Virginia	53	6	59	44.15	6.05	50.20	21.60	28.60
Total	132	34	166	128.33	26.97	155.30	68.24	87.06
Gulf:								
Arkansas	–	1	1	–	7.50	7.50	0	7.50
Texas	–	11	11	–	66.70	66.70	16.00	50.70
Total	–	12	12	–	74.20	74.20	16.00	58.20
Pacific:								
Alaska	–	1	1	–	1.30	1.30	.70	.60
Washington	–	1	1	–	4.80	4.80	4.00	.80
Total	–	2	2	–	6.10	6.10	4.70	1.40
U.S. total[3]	237	169	406	274.52	647.61	922.13	276.93	645.20

– = None.

[1] Includes production from mines which were partially developed before 1979 and production from mines now operating that will expand during the 1979-87 period.

[2] New coal production capacity from mines that are currently expanding or developing combined with production from planned mines.

[3] Excludes mines planned for Georgia and Louisiana.

Sources: (*7, 43, 44, 67, 92*).

One should note that these are planned mines, so various factors–economic, environmental, legal, and others–could add to or delete from this number.

Mining Costs: Surface Mines. The cost of mining coal in any region is an important determinant of its competitive position as to alternative fuels and mining costs in other regions. Several approaches have been used to estimate the average cost of mining a ton of coal. The BOM has employed cost budgeting for "model" mines with different configurations typical of a given region.[16] Using this method one can make assumptions about the kinds and sizes of mining equipment suited for assumed layouts, overburden, and mining plans. Costs can be estimated based on the variables. Several U.S. Department of Energy (DOE) and BOM reports conclude that there are economies of size in coal mining (*8, 39, 100*). As a rule, the larger the annual mine output, the lower the total operating costs per ton of coal mined. Furthermore, the stripping ratio is an important element in determining mining costs. In general, the lower the stripping ratio, the lower the unit cost of mined coal.

Model mine cost budgeting is a site cost technique which requires detailed knowledge of mining and is not easily adapted to assessing mining costs for the large number of potential U.S. mine sites. As these costs are affected by many factors, they must be considered in relation to special situations at each individual mine–such as surface topography, drainage conditions, and character of the overburden. Then, model mine operating costs can be used to show the relative production costs between regions. In a recent DOE report, these costs were $3.25 per ton for the Northern Great Plains, $6.76 for the Interior, and $11.66 for the Eastern Regions (table 8) (*8*). Although model mine statistics for the Rocky Mountain, Gulf, and Pacific Regions were not presented in the DOE report, the surface mining parameters for these three regions generally fall between those of the Northern Great Plains and Interior Regions. Thus, it is logical to assume that their costs would fall within this range–that is, between $3.25 and $6.76 per ton.

In a 1978 study conducted by the Office of Surface Mining (OSM), computer simulation macromodels determined annual operating costs for model surface mines (*111*). The models reflected the typical mining method, production level, overburden depth, seam thickness, years of mine life, type of operations, and the equipment required for a mine in each region. Although the resulting costs per ton are considerably higher than those presented in the DOE report, the relative differences between regions are consistent.[17] The least cost was estimated to be $7.67 per ton for the subbituminous area of the Northern Great Plains and the highest cost, $26.28 per ton, for the south and central areas of the Eastern Region (table 9).

In yet another study, case histories describing pertinent geographic, topographic, geologic, and climatic conditions; mining unit operations; and auxiliary functions of representative mines were combined with detailed systems analysis to estimate costs for typical mining operations (*101*). The variations in unit operations formed the base for evaluating each mine's cost. The results were similar to those of the BOM and DOE studies. The low cost was $4.65 per ton for an area mine in the Northern Great Plains and the high cost was $23.00 per ton for a contour truck haulback mine in the Eastern Region (table 10). (See (*41*) for detailed descriptions of kinds of mining.)

Although there are absolute differences in the estimated mining costs in the three studies discussed here, their general conclusions are similar: (1) Costs per ton are lowest in the Northern Great Plains and highest in the Eastern Region, and (2) the method of mining, which is primarily dictated by topography, size of the mine, and stripping ratios, largely determines cost for surface mining.

Mining Costs: Underground Mines. In some regions, primarily Eastern, Interior, and Rocky Mountain, production from underground mines contributes significantly to total coal production, and cost estimates for underground mining are important. Many interrelated variables, such as roof conditions, seam thickness, age and type of equipment, methane concentrations, and other operating conditions, were considered in model mine development. Values assigned to the variables reflect mining conditions characteristic of each region. Production cost estimates of the representative underground mine models indicate that per ton costs are about $25.50 for the Eastern Region, $20.50 for the Interior, and $15.60 for the Rocky Mountain and Northern Great Plains (*111*). These

[16] The BOM agency responsible for these studies is now a part of the U.S. Department of Energy (DOE).

[17] The cost differences between the OSM and DOE reports are largely attributed to two factors: (1) DOE data are for 1976 and OSM data are for 1978; and (2) the OSM data estimate expected increases in costs due to the 1977 Surface Mining Control and Reclamation Act.

Table 8—Model surface mine parameters for Eastern, Interior, and Northern Great Plains Regions

Item	Unit	Region		
		Eastern	Interior	Northern Great Plains
Annual production	1,000 tons	150	3,360	5,000
Overburden thickness	Feet	60	70	75
Seam thickness	Feet	6	5	57
Stripping ratio	Feet/feet	10:1	14:1	1.14:1
Capital investment	Dollars/ton production[1]	44.45	21.38	10.04
Operating cost	Dollars/ton production[1]	11.66	6.76	3.25

[1] Adjusted to first quarter of 1977.

Source: (*8*).

Table 9—Computer simulation estimates of operating costs for surface mine models, 1978

Region	Mining method	Median production	Seam thickness	Overburden ratio	Mine life	Production cost
		Tons/year	*Inches*	*Feet/feet*	*Years*	*Dollars/ton*
Northern Great Plains:						
Subbituminous area	Area stripping with truck shovel	5,000,000	554	3:1	20	7.67
Lignite area	Area stripping with dragline	2,800,000	119	6:1	20	8.71
Rocky Mountain	Area stripping with dragline	2,800,000	119	6:1	20	8.71
Interior:						
East	Area stripping with dragline	1,400,000	45	19:1	20	17.32
West	Area stripping with dragline	2,300,000	56	15:1	20	14.62
Eastern:						
South and central	Contour stripping with truck shovel	73,000	40	17:1	5	26.28
	Mountaintop removal with truck shovel	300,000	40	17:1	5	26.28
Northern	Area stripping with dragline	160,000	45	15:1	10	23.16
Gulf	Area stripping with dragline	2,800,000	119	6:1	20	8.71
Pacific	Area stripping with dragline	2,800,000	119	6:1	20	8.71

Source: (*111*).

estimates show that per ton underground mining costs are generally much greater than those for surface mines.[18]

It must be stressed that costs estimated from model mines should not be compared directly with actual costs of individual mining operations. Even if production values, mining methods, and stripping ratios are identical to those of a representative model mine, various parameters—such as local topography, geology, hydrology, climate, ecology, and managerial ability—will vary from mine-to-mine and result in costs different from those estimated in model mine analysis. Nevertheless, such analysis does provide a means for comparing relative costs of mining among regions.

[18] Production costs for underground coal mines are generally higher than those for surface mines. In the OSM analysis, however, the design characteristics of the models result in production costs that are slightly higher for the surface model in the central and southern areas of the Eastern Region than the costs for the underground model. This inconsistency results from the difference in the models' design lives and production levels. If the output level and design life for the surface model are adjusted upward to those of the underground model, production costs for the underground model are higher than for the surface model.

Distribution of Coal. Of the 641 million tons of coal distributed in 1978, 601 million tons (94 percent) remained within the United States and 40 million tons (6 percent) were exported (table 11).

The out-of-region distribution pattern differs considerably by region; the relative amount of these shipments indicates a region's current surplus or deficit coal-producing capacity. In 1978, the Northern Great Plains shipped 70 percent of its production out of region, whereas none of the Gulf or Pacific Regions' coal was shipped out of region. During the same period, out-of-region shipments accounted for 41, 34, and 27 percent of the Eastern, Rocky Mountain, and Interior Regions' total coal distribution, respectively. Over half (55 percent) the total coal shipped came from the Eastern Region, followed by the Interior (19 percent) and the Northern Great Plains.

Table 10—Estimated surface mining costs

Region and State	Mining method	Annual production	Average overburden thickness	Average seam thickness	Stripping ratio	Operating costs per ton[1]
		1,000 tons	*Feet*		*Ft. overburden/ ft. coal*	*Dollars*
Northern Great Plains:						
Wyoming	Open pit	3,000	100	27.0	3.7	4.88
Montana	Area	5,000	65	52.0	1.3	4.91
North Dakota	Area	2,000	60	20.0	3.0	4.65
Rocky Mountain:						
Colorado	Area	1,800	70	7.0	10.0	7.42
Interior:						
Illinois	Area	3,000	70	8.0	8.8	6.97
Indiana	Area	1,440	80	4.5	17.8	14.83
Eastern:						
Kentucky	Haulback and mountain top removal	1,750	100	6.7	14.9	16.55
Tennessee	Truck haulback	350	60	14.2	4.2	23.00
West Virginia	Modified block cut	85	60	2.3	26.1	20.07
Pennsylvania	Modified block cut	25	50	2.5	20.1	17.54
	Modified area	120	45	7.8	5.8	14.45
	Scraper haulback	240	50	5.5	9.1	12.58
	Modified area	500	110	3.5	31.4	11.88
Ohio	Modified area	140	40	2.8	14.3	22.11
	Box cut contour	600	80	3.9	20.5	18.34

[1] Cost adjusted to January 1979 using annual average of producers price index (*43*).

Sources: (*43, 100*).

Transportation. In 1978, of the nearly 600 million tons of coal transported within the United States, 324 million tons (or 54 percent) were moved by railroad; 96 million tons (or 16 percent) were moved by river; and 94 million tons (or nearly 16 percent) were moved by truck.[19] Tramways, conveyer belts, private railroads, and slurry pipelines moved an additional 66 million tons (or 11 percent) where the consumption point was located near the minemouth. About 20 million tons (or 3 percent) were moved by other modes, primarily on Great Lakes and tidewater routes (*102*).

The mode of shipment varies considerably among regions. In the Northern Great Plains, 68 percent of the coal is moved by rail. Rail shipments were also predominant in the Rocky Mountain, Eastern, and Interior Regions; 58, 55, and 49 percent respectively, moved by this mode (fig. 5). The Interior and Eastern Regions were the largest users of river shipment, moving 28 and 18 percent, respectively, of their coal by barge. Significant amounts of coal were moved by truck in all regions (except the Pacific). The largest relative amount moved by truck was 21 percent, in the Gulf Region. In the Gulf and Pacific Regions, most of the coal was moved by tramways, conveyer belts, or private railroads.

Coal Usage. The continued growth in the nationwide demand for electricity has been the main force behind the recent surge in coal development. During the 1970-78 period, coal used to generate electric power in the United States increased 39 percent, from 339 million tons to 471 million tons. During the same period, coal used for making coke decreased 41 percent, from 103 million tons to 65 million tons. Retail sales decreased 87 percent, industrial use 20 percent, and exports 33 percent (*102*).

[19] These data do not include about 40 million tons of coal that were exported.

The end use of coal varies by region because of variations in coal quality, demand within a given region relative to demand in other areas, transportation costs, and other factors. Even so, the predominant use of coal in the United States was for the generation of electricity. Over 90 percent of the coal produced in the Northern Great Plains, Gulf, and Pacific Regions was used for this purpose in 1978 (fig. 6). Relatively less coal from the Eastern Region, about 69 percent of total production, is used for electricity generation; most of its remaining coal is used for making coke (19 percent) and for other industrial uses (11 percent). For the Rocky Mountain and Interior Regions, respectively, 81 and 85 percent of production is used for electricity generation, 8 and 12 percent for making coke, and 10 and 12 percent by other industries. Small amounts of coal are still sold on the retail market in all regions except the Gulf.

Projections and future plans are made on the premise that the electric utility component will continue to increase. Of the projected 645 million tons of new coal production capacity scheduled for 1979-87, about 570 million tons, or 88 percent, are classified as steam coal. Of the remaining 75 million tons, 50 million tons are scheduled for the metallurgical market (coke) and 24 million tons for possible conversion into synthetic gas (*7, 44, 67*).

In all regions except the Eastern, the largest proportion of coal to be produced from new capacity is targeted for the electric utility sector. Of the 331 million tons from the Northern Great Plains, 316 million tons (95 percent) are scheduled for the electric utility market, with the remaining 15 million tons to be used for gasification. For the Rocky Mountain Region, 104 million tons are to be used by electric utilities, 6.5 million tons for gasification, and about 2 million tons as metallurgical coal. The Eastern Region will supply most of the metallurgical coal, 45 million tons, as well as 39

Table 11—Distribution of coal, by region, 1978

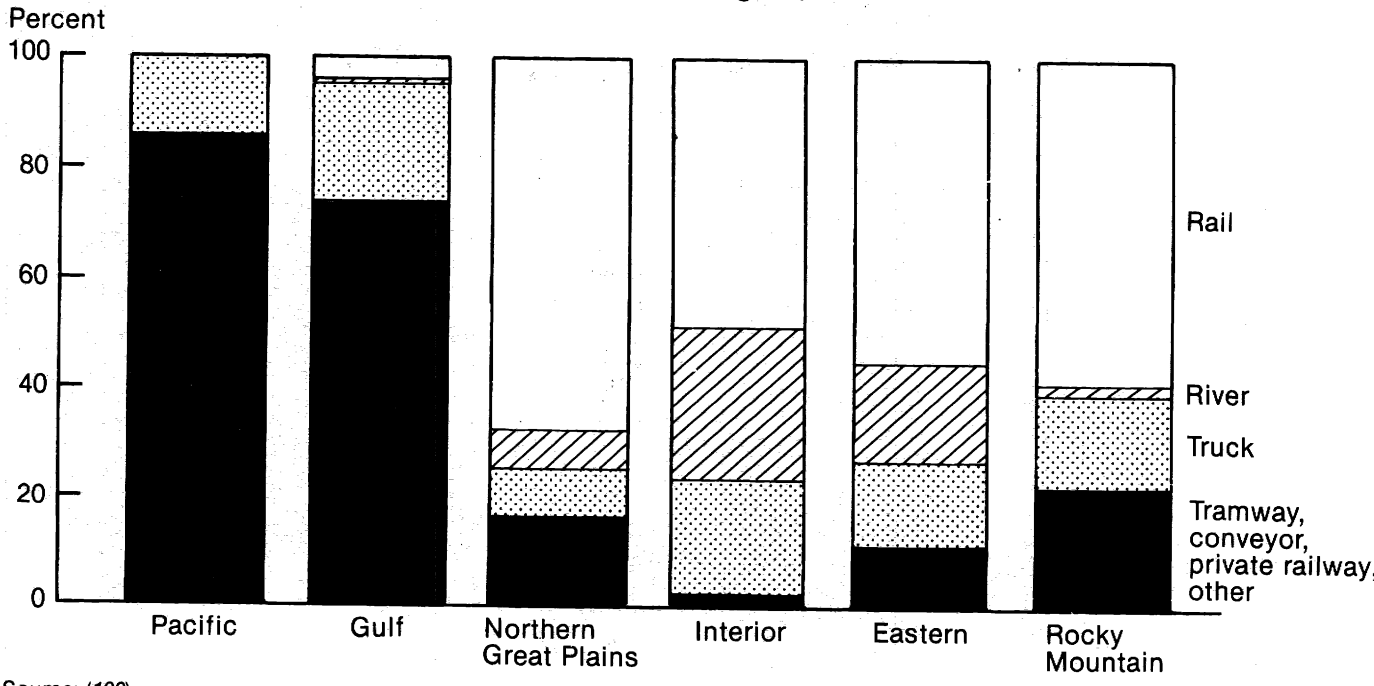
Region	Total distribution[1]		Out-of-region shipments	
	1,000 tons	*Percent*	*1,000 tons*	*Percent*
Northern Great Plains	98,866	15.4	69,388	70.2
Rocky Mountain	44,161	6.9	14,806	33.5
Interior	121,600	19.0	32,516	26.7
Eastern	349,870	54.6	141,761	40.5
Gulf	21,006	3.3	0	0
Pacific	5,443	.9	0	0
United States	640,946	100.0	[2]40,386	[2]6.3

[1] For conceptual reasons, total distribution amounts differ from production.
[2] Exports.

Source: (*102*).

Figure 5

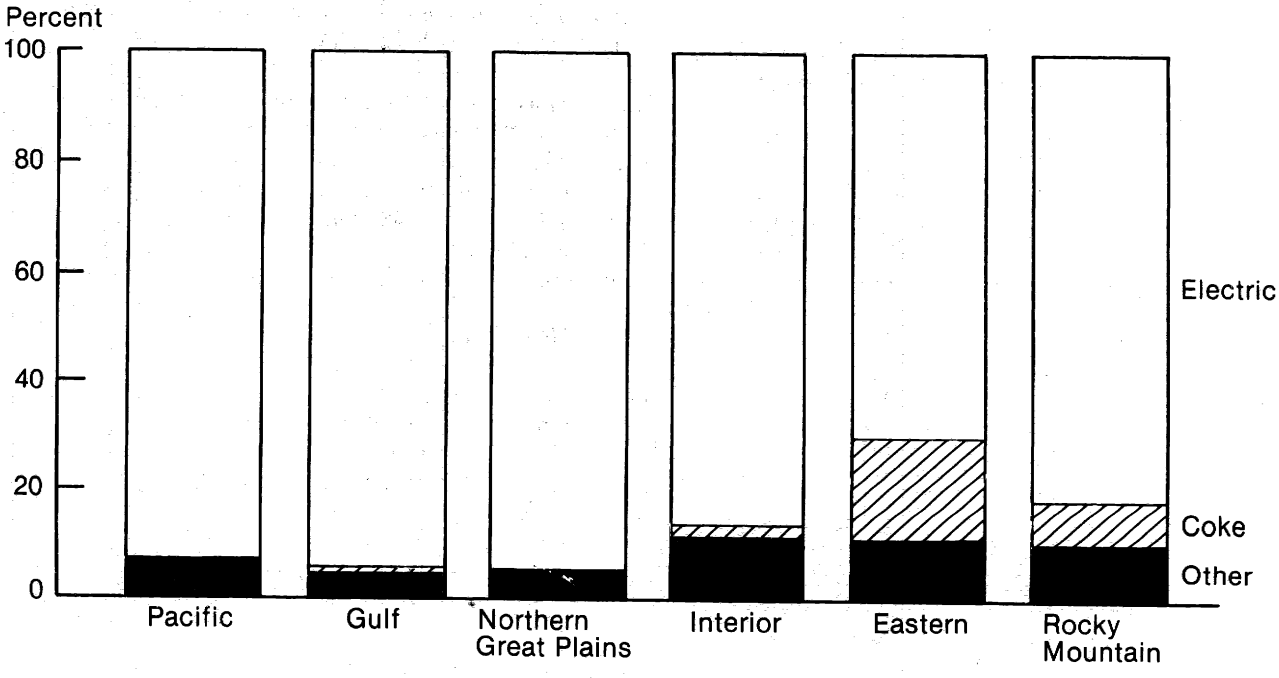
Coal Shipments by Method of Movement and Region, 1978



Source: (*102*).

Figure 6

End-Use of U.S. Coal by Region, 1978



Source: (*102*).

million tons of steam coal and 2.5 million tons for gasification. The Interior Region will contribute 52 million tons of steam coal and about 3 million tons for gasification. Both the Gulf and Pacific Regions will produce steam coal only, supplying an additional 58 million tons, and 1.4 million tons, respectively, by 1987 (*7, 44, 67*).

These projections of demand for coal are based on current conditions, which might be changed by factors unrelated to the mining process. For example, Federal sulfur dioxide emission standards and other air quality standards may be revised again, which might affect the quantity of coal demanded from any given region. Other actions in the near future could affect the overall demand for coal, such as further price increases of oil by the Organization of Petroleum Exporting Countires (OPEC). The pricing of oil is extremely important as coal and oil are substitutable in several uses, including the generation of electricity, especially medium- to long-term. Different patterns of coal transportation via rail or slurry pipeline might develop in response to various constraints, thereby altering demand patterns. The interplay of such factors is to be analyzed by an econometric model, currently used by ESS research people to analyze the impacts of changes in public policy relating to coal development (*24*).

Table 12–Surface-mined coal land needing reclamation, by region, July 1977

Region	Land needing reclamation[1]		
	Not required by law	Required by law	Total
	Acres		
Northern Great Plains	13,552	73,519	87,071
Rocky Mountain	8,146	5,037	13,183
Interior	332,592	156,624	489,216
Eastern	734,948	328,715	1,063,663
Gulf	3,320	3,736	7,056
Pacific	2,748	1,190	3,938
Other[2]	1,832	1,267	3,099
U.S. total	1,097,138	570,088	1,667,226

[1] Includes land adjacent to the actual mining area whose natural state has been disturbed by the mining operation.

[2] Includes California, Georgia, and Michigan, States with extremely small coal reserves, and those not classified in Coal Production Regions.

Source: (*82*).

Reclamation of Mined Land

Erosion, sedimentation, impaired drainage, degraded water quality, loss of productivity, and loss of aesthetics have damaged many areas where surface mining has occurred. While the adverse effects of surface mining in the East have been researched and are well documented, less is known about the potential damage from mining in the West. It is known that western coal seams are sometimes major aquifers and that aquifer disruption caused by surface mining could become a serious problem. Furthermore, many soils in the West are alkaline, and as the overburden is disrupted, the salts become susceptible to leaching, which in turn can contaminate the water. As mining in the West increases, additional environmental problems may be discovered.

The Soil Conservation Service estimates that on July 1, 1977, about 1.7 million acres of land surface mined for coal in the United States needed to be reclaimed (table 12) (*82*). About 1.1 million acres were mined prior to passage of surface mining laws and, therefore, reclamation was not required by law. The remaining 570,000 acres were mined under Federal, State, or local laws that required reclamation. Nearly two-thirds of the land needing to be reclaimed (1.1 million acres, or 64 percent) is in the Eastern Region. Most of the rest, 29 percent, is in the Interior Region. About 735,000 acres in the Eastern Region and about 333,000 acres in the Interior Region are not required by any law to be reclaimed. The only other region with significant acreages needing to be reclaimed is the Northern Great Plains, with 87,000 acres, of which 73,500 acres were mined under specific laws that require reclamation. In addition to the land which has been disturbed and needs reclamation, about 10,500 miles of streams, mostly in the Eastern and Interior Regions, have been affected adversely by mine drainage (*37, 82*).[20]

The increased demand for coal in recent years has created pressures to use even more land for coal production. This has increased land use conflicts based on controversies between economic, environmental, social, and aesthetic interest groups and, in many cases, has heightened opposition to surface mining. In response to this opposition, reclamation has recently become an integral part of the mining process.

Goals of Reclamation

Reclamation is intended to minimize adverse effects during and after mining and to return surface-mined land to productive use. The reclamation process accomplishes these goals by (1) alteration of the contour and topography of the land subsequent to mining, (2) preparation of the land for rapid reestablishment of vegetation, and (3) abatement of water pollution resulting from mining (*19, 83*).

[20] These streams are polluted by increased amounts of acid, sediments, sulfates, iron, and hardness. Over 70 percent of the acid mine drainage originates in underground mines.

Alteration of the contour and topography of mined land is accomplished by backfilling and grading. Backfilling refers to placing spoil (waste material removed by mining) back into the mined area; grading then determines the final condition of the spoil surface. These two operations help determine the potential use of the mined land and, when properly conducted, can aid in reducing adverse environmental impacts of mining—such as landslides, land subsidence, erosion, water pollution, and aesthetic degradation (*19, 113*).

Since many untreated spoils are toxic to vegetation, because of acidity or alkalinity, the mined land must be prepared for rapid reestablishment of vegetation. This preparation includes any action which improves the spoil surface and increases the chances of establishment and survival of plants. This includes seeding and/or planting the land, improving texture, chemistry, and moisture retention ability of the spoil. One way to improve soil characteristics is by replacing topsoil after mining. In most instances, topsoil is beneficial to vegetation because its texture, chemistry, and moisture-retention characteristics are superior to those of unconsolidated spoil. Disking, subsoiling, ripping, or other tillage practices also improve spoil texture and moisture-retention characteristics as well as provide a roughened surface where seeds and seedlings can be held in place until plants are established (*19, 32, 83*).

Abatement of water pollution resulting from mining can be accomplished either by eliminating the conditions which lead to water pollution or by treating runoff from the mined area. The first approach prevents the water from entering the mining environment, thus keeping it away from pollution sources such as sulfur-bearing coal and overburden. Other methods which can be used to prevent water pollution are the installation of diversion ditches around the top and sides of the mine, the sealing of fractures, and the placement of highly polluting materials where contact with water is avoided. For mine drainage which cannot be prevented, several methods of treatment are available. One popular method of treatment involves collecting runoff in a sediment pond located below the mine. Once in the pond, the sediment is allowed to settle out and the mine effluent is neutralized by chemical treatment. Other methods of treatment include ion exchange, reverse osmosis, and electrochemical oxidation (*19, 29, 113*).

Legislation

Although some mining companies have practiced reclamation for years, in the past it was not a general practice largely because of the expense involved. Although early surface mining laws were passed in West Virginia (1939), Indiana (1941), Illinois (1943), Pennsylvania (1945), and Ohio (1947), they addressed only the basics of reclamation, such as revegetation and erosion control (*36*).

During the fifties and sixties, existing laws were revised and additional States adopted laws which generally added requirements for soil conservation and water quality control. By 1970, all the mining States in the Eastern Region and half those in the Interior had adopted reclamation laws. However, none of the States in the Rocky Mountain, Gulf, Pacific, or Northern Great Plains Regions, except North Dakota, had imposed reclamation laws. As surface mining activity increased in these regions, legislatures responded to social pressures for environmental protection, and by 1975 all major coal-producing States had adopted reclamation laws (*17, 36*).[21]

Surface mining and reclamation laws vary among States because of topographic and climatic conditions. Laws also vary among States in the extent and effectiveness of their coverage as well as in the regulatory agency's willingness to enforce the law. Thus, mining companies operating in States with stringent and highly enforced regulations are at a competitive disadvantage when compared with those operating in States with minimum regulations. Realizing the unwillingness of some States to accept responsibility for adopting and enforcing laws which would adequately protect the environment, the Congress passed the Surface Mining and Reclamation Act of 1977 (*77*). The purpose of the act was to "(a) establish a nationwide program to protect society and the environment from the adverse effects of surface coal mining operations." Twelve other purposes, (b) through (m) as listed in the act, elaborated upon the main purpose. Specifically mentioned were provisions intended to protect the rights of surface landowners, to prevent undue losses in agricultural productivity, to protect the environment, to require prompt reclamation of mined land, to promote the reclamation of previously mined but unreclaimed land, to provide for public participation in preparing regulations and standards, and to provide for data collection, research, and analysis for improving mining and reclamation techniques. Two of the listed purposes deserve special emphasis. One was to provide assistance to States in developing programs to achieve the purposes of the act; the other was to assure coal supplies adequate to serve national energy requirements while maintaining a balance between coal mining, agricultural productivity, and environmental protection.

The 1977 act transfers the regulatory jurisdiction over coal mining and reclamation to the Federal Government, with the Office of Surface Mining (OSM) as administering agency. It is the intent of the act to allow individual States to reassume the primary regulatory authority role by incorporating the Federal minimum standards into their laws and by developing

[21] For Alaska and Arizona, mining is on Indian, Federal and/or State lands; case-by-case State regulatory decisions and/or Federal coal leasing regulations apply to mining and reclamation in these States.

permit and enforcement programs approved by OSM. Under an OSM-approved program, an individual State has the authority to develop more stringent regulations, issue permits, make inspections, issue citations, and perform other pertinent functions. Even though a State may have an approved program, OSM has the authority to duplicate enforcement (*77*).

Unlike previous reclamation laws which permitted varying degrees of reclamation on a State-by-State basis, the 1977 act establishes minimum environmental performance standards for mining and reclamation on all lands, and it provides for numerous other objectives such as the reclamation of abandoned mines, assistance in mitigating energy development impacts, and funding for State mining and mineral resources institutes.

Although there has been, and will continue to be, considerable debate on the advantages and disadvantages of Federal regulations, the fact remains that they now exist. Their immediate impact will vary from State to State, depending largely on the degree of reclamation and enforcement formerly in effect. In those States where reclamation laws were stringent and enforcement requirements strict, the impacts will be less than in States where requirements were minimal. However, it is generally agreed that the 1977 act will have far ranging effects on the U.S. coal industry.

Reclamation Costs

Reclamation costs may be separated into three broad categories, including premine planning, backfilling and grading, and revegetation. The costs associated with premine planning generally consist of (1) an engineering study, including mapping of the mine site, a study of drainage patterns, and development of data to support the permit application; (2) the design and construction of pollution control systems; and (3) the costs of bonding, permits, and application fees (*21, 63*).

Backfilling and grading costs, which are difficult to apportion between mining and reclamation, include (1) removing vegetative cover from the area to be mined, (2) removing and stockpiling topsoil, (3) backfilling the disturbed areas with spoil, (4) grading the spoil, and (5) replacing the topsoil.

Depending on revegetation requirements and intended postmining land use, revegetation includes combinations of the following operations: (1) soil preparation, such as disking, harrowing, and gouging; (2) addition of amendments, such as lime and fertilizer; (3) seeding and/or planting; (4) mulching; and (5) irrigation.

The topography of the mine site dictates the mining and reclamation method to be used and influences cost. Site conditions present varying degrees of difficulty in completing the required reclamation. The two basic methods of mining are area and contour, with various modifications. The area method, which is normally utilized in level or gently rolling topography, tends to hold down reclamation costs by limiting the handling of overburden material. The placing of overburden in the previous cut eliminates excessive handling and also allows the same machinery to be used in both the mining and reclamation processes. The contour and similar methods require removal of the overburden and its return or placement in the fill. This added handling, along with decreased machinery effectiveness, adds to reclamation costs. Furthermore, if an unmined fill is used for disposition of spoil, this area too must be reclaimed.

Case studies of representative surface mines show that per acre reclamation costs vary considerably both among and within regions (*21, 63, 101.*)[22] However, reclamation costs are generally lowest in the Gulf Region and highest in the Eastern Region (table 13). Backfilling and grading is the most costly operation, but it varies from less than 60 percent of total cost in the Gulf Region to over 90 percent in the Eastern Region and in the eastern portions of the Interior Region. Premining planning ranged from less than 5 percent of total cost in the Interior and Eastern Regions to 40 percent in the Gulf Region. Revegetation accounted for less than 10 percent of total cost in all regions, except the arid sections of the Rocky Mountain Region where irrigation increased revegetation costs to 14 percent of the total per acre reclamation costs.

Reclamation costs expressed as dollars per acre are useful for various purposes, such as determining the amount of bond an operator must post to assure acceptable reclamation. Costs expressed in dollars per ton provide for relative comparison of reclamation costs with other mining costs. Per ton mining costs for the aforementioned representative surface mines range from a low of 8 cents per ton, for an area mine producing 3 million tons per year in the Northern Great Plains, to over $6 per ton, for a contour mine producing 208,000 tons per year in the Eastern Region.[23]

Data on combinations of surface mining methods, slope degrees, and production capacity indicate that per ton reclamation costs are less (1) for area mines, (2) on sites with less

[22] Reclamation costs for the Pacific Region are not included. However, mining methods are similar to those used in the Northern Great Plains.

[23] These costs do not include incremental amounts attributed to the permanent regulatory program of the Surface Mining Control and Reclamation Act of 1977. Although these incremental costs vary considerably, estimates for model mines indicate that the dollar per ton increases could be as follows: Northern Great Plains, 0.03; Rocky Mountain, 0.10; Interior, 0.30-0.38; Eastern, 0.43-1.87; Gulf, 0.30; and Pacific, 0.10 (*111*).

Table 13—Estimated averages of mined land reclamation costs, by region, 1978

Region and State	Site[2] number	Mining method	Annual production	Average slope	Mined area	Average costs[1]							
						Premining		Backfilling and grading		Revegetation		Total	
						Per ton	Per acre	Per ton	Per acre	Per ton	Per acre	Per ton	Per acre
			1,000 tons	*Degrees*	*Acres/ year*	*Dollars*							
Northern Great Plains:													
Montana,	1	Area	3,200	<10	100	0.01	538	0.16	5,054	<0.01	195	0.17	5,787
North Dakota	2	Area	1,300	na	140	.07	688	.31	2,773	.01	135	.39	3,597
and Wyoming	3	Area	3,000	na	80	.01	344	.07	2,349	< .01	172	.08	2,865
Rocky Mountain:													
Arizona and New Mexico	1&2	Area	na	na	na	.06	917	.10	1,925	.01	401	.17	3,243
Colorado	3	Area	na	na	na	.08	825	.17	1,639	< .01	40	.25	2,504
Interior:													
Kansas and Missouri	1-6	Area	na	na	na	.24	1,106	.44	1,719	.01	52	.69	2,877
Indiana, Illinois, and Ohio[3]	1	Area	720	10	220	.10	358	2.78	9,077	.14	478	3.02	9,913
	2	Contour	650	15	460	.15	213	4.89	6,911	.35	501	5.39	7,625
	3	Area	1,300	5	150	.06	430	2.50	18,340	.03	143	2.59	18,913
	4	Contour	6,000	17	2,400	.15	390	4.91	12,249	.08	188	5.14	12,827
	5	Area	900	5	192	.07	365	1.47	6,912	.04	154	1.58	7,431
Eastern:													
Alabama, Kentucky,[4] and Tennessee	1	Contour	130	25	65	.46	931	4.31	8,629	.23	458	5.00	10,018
	2	Contour	30	25	10	.25	240	4.80	4,806	.43	426	5.48	5,472
	3	Contour	208	24	120	.37	656	5.51	9,548	.23	413	6.11	10,617
	5	Contour	543	25	180	.09	420	4.08	18,483	.12	555	4.29	19,458
	7	Area	250	10	90	.06	169	1.21	3,389	.04	96	1.31	3,654
	8	Area	250	10	40	.05	332	1.63	10,163	.06	432	1.74	10,927
	9	Area	1,280	10	360	.17	573	2.48	8,828	.01	61	2.66	9,462
Maryland,	1	Area	800	9	180	.05	234	1.43	6,345	.10	447	1.58	7,026
Pennsylvania,	2	Contour	180	25	90	.13	265	4.84	9,695	.22	433	5.19	10,393
Virginia, and	3	Contour	15	20	6	.10	258	3.19	7,956	.19	478	3.48	8,692
West Virginia	4	Contour	45	15	12	.06	223	4.13	15,487	.04	129	4.23	15,839
	5	Area	108	10	29	.06	243	2.78	10,315	.08	284	2.92	10,842
	6	Area	100	100	8	.05	217	2.53	10,110	.09	317	2.67	10,644
Gulf:													
Texas	1	Area	na	na	na	.06	504	.08	722	.01	40	.14	1,266

na = Not available.

[1] Costs adjusted to 1978 by using ICF's past and projected reclamation cost index (*33*).

[2] Site numbers designated by U.S. Bureau of Mines (*21, 63*). Combined analysis for sites 1-6 in Kansas and Missouri and sites 1 and 2 in Arizona and New Mexico. Sites 4 and 6 in the Eastern Region were excluded due to special operating conditions.

[3] Due to the similarity of mining and reclamation methods, Ohio is included with Indiana and Illinois for reclamation cost analysis.

[4] Includes both eastern and western Kentucky.

Sources: (*21, 33, 63*).

than 20° slope, and (3) on sites with 500,000 tons or more annual production (*21, 63*).

Given these general relationships, one should recognize that surface mining is a site-specific undertaking. Each mine is different and represents a different reclamation situation. Interaction of various factors–such as topography, thickness and composition of the overburden, thickness and character of the coal seam, hydrological characteristics, climate, mining method, size and type of equipment used, reclamation laws, postmining land use, and accounting procedures–limit the accuracy of predicting reclamation costs. Even so, examining reclamation costs for representative mines allows a general comparison of mined land reclamation costs within and between U.S. regions.

The Land Resource

Relatively little farmland will likely be disturbed by the increased surface mining of coal. Any loss of agricultural production because of mining would not be serious regionally or nationally. Losses of farm income as a result of land disturbance by strip mining will probably total about $16 million annually for all the coal regions, or less than 0.2 percent of the $11 billion total farm income for these regions.

Landownership

Patterns of landownership vary widely among the coal production regions, due largely to the difference in settlement patterns. In the Eastern, Interior, and Gulf Regions, most of the land is privately owned, whereas in the three western regions, a substantial part is publicly held, that is, by Federal, State, or tribal governments. Settlement history had a decisive role in establishing ownership patterns. Some of the land titles in the Eastern Region can be traced back to grants to colonists from the British Crown before the Revolutionary War. Virtually all the land in the Eastern Region and most of the eastern part of the Interior Region had passed into private ownership by the 1850's. In most of the Northern Great Plains, Rocky Mountain, and Pacific Regions, little settlement occurred prior to the passage of the Homestead Act of 1862, and at that time most of the land was still in the public domain. As one of the purposes of the Homestead Act was to settle the land for agriculture, the first homesteaders chose the best land, or the land most accessible to transportation routes, leaving the poorest or most remote land until last. The land least suited to farming or ranching was not settled at all, but remained in the public domain. It is now administered by the Bureau of Land Management (BLM).

The homesteading period lasted until about 1920, by which time all the land suitable for crop production without irrigation had been taken. During this period, however, large areas in the West were withdrawn from public entry for special purposes, such as the creation of national forests, national parks, and national wildlife refuges. Where public domain land was not available for special purposes, as in most of the area east of the Mississippi, land was purchased from private owners. During the homesteading period, grants of land were made to States and railroads, and Indian reservations were formed.

In the Rocky Mountain Region, more than 40 percent of the land is in Federal ownership, of which 18 million acres are administered by BLM, while the Forest Service has nearly 15 million acres (table 14). Indian ownership accounts for 21.5 percent of the land and the States own 6.4 percent, leaving only 31.7 percent in private ownership. Indian land is concentrated mainly in three CPA's, namely AZ-1, NM-1, and NM-2 (app. table 4).

In the Northern Great Plains, BLM owns most of the public land although the Forest Service and Indian tribes own important acreages. Railroad companies–especially the Burlington Northern–have a substantial part of the privately owned land in the Northern Great Plains and in part of the Rocky Mountain Region. Grants made to railroads by the Federal Government were in alternate sections for specified distances on either side of the main line right of way.[24] The resulting checkerboard pattern of ownership persists in most areas where land grants were made (*96*).

In the Interior, Eastern, and Gulf Regions, the Forest Service is the principal owner of Federal land. Most of the land in these three Regions had passed into private ownership long before the National Forests were established, so the land needed for the forests was purchased from private owners. The Interior Region contains a small amount of Indian land, mostly in the CPA's in Oklahoma.

Data for other owners of public lands are not available by counties for the Interior, Eastern, and Gulf Regions, so a tabulation by CPA's was not possible; however, data by State show that federally owned land is uncommon. In Arkansas and Virginia, the two States with the most Federal land, 9.8 and 9.1 percent, respectively, are federally owned (table 15). Most of this is in National Forest, although the Corps of Engineers has substantial holdings, much of which is water surface for flood control or hydro power. The Tennessee Valley Authority (TVA) is an important Federal owner in the Eastern Region. TVA also owns large acreages of water surface for dams and reservoirs. Some States, like Iowa, Ohio, Kansas, and Illinois, have less than 2 percent of their total area in Federal ownership.

[24] A section, a unit of land measurement, typically a square measuring 1 mile on each side, contains 640 acres.

The Pacific Region contains two areas vastly different in landownership. In the CPA's located in Washington, the pattern is somewhat analogous to that of the Rocky Mountain Region—more than a third of the land is Federal (primarily Forest Service). The ownership pattern in Alaska is difficult to describe, partly because of unsettled claims on the part of the State and the native tribes.[25] Before Alaska was admitted to the Union in 1959, 99.8 percent of the land was Federal, mostly administered by BLM, although there were two national forests and some land in military reservations. With statehood came confusion in landownership (*1*). The Statehood Act and other laws provided for the State to receive 104 million acres, but by 1971, only about 26 million acres had been selected for State ownership (*95*). Native claims were established at 40 million acres by the Congress in 1971. The exact location and acreage of all State and native claims has not yet been settled, but it is estimated that eventually the State will own about 28 percent of the land, native tribes almost 12 percent, and private owners about 0.3 percent (*95*). The vast majority of Alaska's land is likely to remain in public ownership for many years to come.

[25] Alaska was omitted from table 14 and appendix table 4 because comparable data were impossible to obtain.

Ownership of Coal Rights

The previous discussion of landownership refers to surface ownership only; the owner of the surface does not necessarily own any of the minerals underneath. Coal is no exception; in some areas there may be several seams, each one owned by still another party. Geographic patterns of coal ownership vary considerably because of differences in how the coal rights became separated from the surface rights. The right to mine coal or other minerals can be bought and sold separately, and such transactions have been common throughout U.S. history. When the country was first settled, colonists and settlers usually obtained unrestricted title to the surface of the land and everything underneath. But there were exceptions even then. For example, in some grants from the British Crown, "precious metals" were reserved, presumably gold and silver (*27*). Later, the United States transferred land to settlers, to the States, to railroads, and to certain development corporations, all under the provisions of a series of congressional acts, including the well-known Homestead Act. In most cases the new owner obtained title to both the surface and the minerals. As the purpose of settlement was usually for farming or grazing, surface rights were initially regarded as more useful, and therefore more valuable, than mineral rights. Later, when minerals were discovered or believed present, a market developed for

Table 14—Land in public ownership in Coal Production Regions, by agency[1]

Region	Bureau of Land Management	Forest Service	Recreation and wildlife	Military	Other Federal agencies	Total Federal[2]	Indian land	State	Private	Total land area[2]
	1,000 acres									
Northern Great Plains	11,078	4,457	309	979	187	17,011	4,262	3,747	51,982	77,003
Rocky Mountain	18,369	14,863	1,879	396	1,118	36,625	19,546	5,767	28,790	90,728
Interior	na	1,270	na	na	na	na	179	na	na	73,014
Eastern	na	1,974	na	na	na	na	0	na	na	56,943
Gulf	0	404	0	405	9	819	0	na	na	24,476
Pacific[3]	17	1,792	627	203	14	2,653	13	482	4,137	7,286
All regions[2]	29,464	24,760	na	na	na	na	24,000	na	na	329,450
	Percentage of total area									
Northern Great Plains	14.4	5.8	0.4	1.3	0.2	22.1	5.5	4.9	67.5	100.0
Rocky Mountain	20.2	16.4	2.1	.4	1.2	40.4	21.5	6.4	31.7	100.0
Interior	na	1.7	na	na	na	na	.2	na	na	100.0
Eastern	na	3.5	na	na	na	na	0	na	na	100.0
Gulf	0	1.7	0	1.7	[4]	3.3	0	na	na	100.0
Pacific[3]	.2	24.6	8.6	2.8	.2	36.4	.2	6.6	56.8	100.0
All regions	8.9	7.5	na	na	na	na	7.3	na	na	100.0

na = Not available.
[1] For sources and explanation of details, see appendix table 5.
[2] Data may not add to total because of rounding.
[3] Excludes Alaska.
[4] Less than 0.5 percent.

Table 15—Federal landownership in Interior and Eastern Regions, 1975

Region	Bureau of Land Management	Forest Service	Fish and Wildlife	National Park Service	Department of Defense		TVA[1]	Other Federal	Total Federal	Indian land[2]	All other	Land area	Ratio of Federal land to total land
					Corps of Engineers[1]	Military							
	1,000 acres												*Percent*
Interior:													
Arkansas	2	2,463	132	28	553	95	0	1	3,274	0	29,971	33,245	9.8
Illinois	*	254	56	*	191	51	0	11	563	0	35,116	35,679	1.6
Indiana	0	179	8	4	116	176	0	4	486	0	22,616	23,102	2.1
Iowa	0	0	26	2	176	20	0	1	224	4	35,574	35,802	.6
Kansas	1	108	22	1	320	167	0	[3]94	712	27	51,605	52,344	1.4
Missouri	*	1,452	43	82	495	73	0	4	2,150	*	42,007	44,157	4.9
Oklahoma	8	291	80	1	865	182	0	[3]87	1,513	1,264	41,243	44,020	3.4
Total Interior	10	4,746	367	118	2,716	764	0	202	8,922	1,295	258,132	268,349	3.3
Eastern:													
Alabama	3	637	9	6	74	179	214	1	1,123	0	31,907	33,030	3.4
Kentucky	0	648	2	62	311	162	159	5	1,349	0	24,504	25,853	5.2
Maryland	0	0	22	31	8	126	0	15	202	0	6,567	6,769	3.0
Ohio	*	164	8	*	103	37	0	18	330	0	26,052	26,382	1.3
Pennsylvania	0	506	8	13	104	30	0	7	669	0	28,344	29,013	2.3
Tennessee	0	618	21	256	191	149	515	[4]39	1,788	0	25,248	27,036	6.6
Virginia	0	1,618	72	269	114	282	2	29	2,385	0	23,738	26,123	9.1
West Virginia	0	958	*	1	105	2	0	4	1,069	0	14,407	15,476	6.9
Total Eastern	3	5,150	142	638	1,010	967	889	118	8,917	0	180,767	189,682	4.7

*Less than 500 acres.

[1] A substantial part of this is water surface.

[2] From U.S. Bureau of Indian Affairs, as of Sept. 30, 1977 (*93*).

[3] Nearly all of this is owned by the U.S. Bureau of Reclamation (93,500 acres in Kansas and 70,800 acres in Oklahoma).

[4] About 37,000 acres of this was owned by the Atomic Energy Commission.

Source: U.S. Bureau of Land Management, except as noted, as of June 30, 1975 (*98*).

mineral rights separate from surface rights. In the Appalachian area, which includes most of the CPA's of the Eastern Region, the land was mountainous and forested, and thus not well suited to agriculture, although it was known to have ample coal resources. Coal land–known or potential–became concentrated in the hands of relatively few individuals or firms, many of them with railroad, mining, or lumbering interests. Later coal mining became a major industry and land was valued for its coal, rather than for its agricultural, potential. Coal mining companies and other interested individuals and firms bought and sold coal rights, with the idea of obtaining enough coal reserves to permit the long-term operation of large mines. Consequently, there are counties in Appalachia where a few firms or individuals own all or most of the coal, although the surface of the land may be separately owned (*45*).

In the Eastern, Gulf, and most of the Interior Regions, the land surface is owned primarily by private individuals or corporations, and very little is publicly owned. In some CPA's, there are some National Forests and other special-purpose Federal land, but most of this land had once been in private ownership and was purchased by the United States. In many such purchases the Government obtained only surface rights, the mineral rights having been retained by the previous owner. In the States of the Eastern Region, the Federal Government owns the coal rights on only about 145,000 acres, and in the Interior Region, on about 40,000 acres (table 16). Most of the Federal coal rights are in AL-1, although significant acreages are located in OH-4 and KY-5. In the Interior Region, most of the acreage with Federal coal rights is in Kentucky.

Most of the land in the western CPA's was homesteaded, and until the turn of the century, mineral rights were transferred with the land. During the 1900-10 period, Federal policy on coal rights changed, first by executive order and in 1910 by act of Congress.[26] Coal rights to much of the land homesteaded in the Northern Great Plains and Rocky-Mountain Regions were consequently reserved to the United States.

Land granted to railroads and to the States included mineral rights. The railroad companies generally sold their land to settlers as soon as any demand arose but retained mineral rights whenever they had reason to believe that any worthwhile deposits might be found. Much of the land in eastern North Dakota was sold by the Northern Pacific[27] with no reservation as to mineral rights, whereas farther west and in Montana, the company reserved coal and iron rights in part of the land and all minerals in another part. Some of the original grant land was never sold and the railroad still owns both the surface and the coal.

Ownership of Coal Reserves

Statistics showing ownership of coal rights do not tell the whole story because vast areas have no coal and the question of who owns the coal rights is moot. Comprehensive data on the ownership of coal reserves are not available, partly because one must obtain data showing ownership of both the land and the mineral rights as well as the location and extent of coal deposits for each tract. The practice of leasing coal rights to mining companies further complicates obtaining statistics to show who owns the reserves and the amount

Table 16–Federally owned coal areas under non-Federal surface, Interior and Eastern Coal Production Areas (CPA's)

Interior Region		Eastern Region	
CPA	Acres	CPA	Acres
AR-1	1,228	AL-0[1]	3,111
IL-0[1]	186	AL-1	88,669
IL-1	692	KY-2	–
IL-2	42	KY-3	285
IL-3	2,184	KY-4	–
IL-4	80	KY-5	11,822
IL-5	103	KY-6	173
IL-6	60	MD-1	[2]3,662
IN-1	–	OH-1	4,842
IN-2	–	OH-2	–
IN-3	118	OH-3	–
IA-0[1]	655	OH-4	[3]18,800
IA-1	40	PA-1	–
IA-2	625	PA-2	6,797
KS-1, 2, 3	–	TN-1, 2	–
KY-0[1]	14,774	VA-1	–
KY-1	12,362	WV-1	–
MO-0[1]	1,003	WV-2	–
MO-1	918	WV-3	–
MO-2	829	WV-4	[2]7,591
MO-3	1,908	WV-5	–
MO-4	590	WV-6	–
MO-5	1,531		
OK-1, 2	–		
Total	39,928	Total	145,752

– = 0.
[1] Indicates land in counties which are not included within the boundaries of any CPA.
[2] Surface is State owned.
[3] Includes 200 acres of State-owned surface.

Source: (*118*).

[26] For details, see (*42*).
[27] The former Northern Pacific Railroad, which is now a part of the Burlington Northern Railroad.

each party owns. In the West, however, the BLM has devised a way of developing meaningful data to show the amount of coal owned by the Federal Government.

In six States, the U.S. Geological Survey (USGS) has delineated Known Recoverable Coal Resource Areas (KRCRA's), which are to encompass all places where minable coal reserves are located. The total area of the KRCRA's delineated up to 1978 is 17.3 million acres, and when mapping is complete, it is expected that about 25 million acres will be included (*96*, pp. 2-5). From maps and other data sources, the BLM tabulated each quarter-section tract by classes of public ownership—that is, Federal, by agency; State; and Indian. Surface rights and coal rights were tabulated separately (*97*).

In the KRCRA's of the six western States, the Federal Government owns 65.9 percent of the coal acres, but only 5 million acres of the surface (table 17). There are 5.9 million acres of Federal coal under privately owned surface. In Montana and North Dakota, much of the privately owned coal land belongs to the Burlington Northern Railroad, which is believed to be the largest corporate owner of coal resources in the country (*42*). Data are not available to show the extent to which the private coal land is owned separately from the surface, but for most such land the surface owner probably does not own the coal. In this study, no KRCRA's were established within the boundaries of Indian reservations, although some have large coal reserves (see footnote 2, table 17). Thus, the Indian coal acreage is grossly understated in table 17.

Among the CPA's, the largest acreage of Federal coal is in WY-2, with nearly 2 million acres, mostly under privately owned surface. In WY-4, there are about 1.4 million acres of Federal coal, mostly under federally owned surface. NM-1 and MT-5 also have more than 1 million acres of Federal coal land. In the three North Dakota CPA's and in CO-7, the United States owns one-third or less of the coal area of the KRCRA's. In WY-1, WY-2, MT-5, CO-4, and all the New Mexico and Utah CPA's, the Federal Government owns more than three-fourths of the coal.

Data similar to those shown in table 17 are not available for any of the other CPA's. In the Eastern, Interior, and Gulf Regions, there is very little Federal coal, as suggested by the data in table 16. The BLM has estimated that 3 percent of the coal reserves in Alabama are federally owned, but in the other States in those three regions, there is not enough Federal coal to mention (*96*, p. 2-1). Nearly all coal is privately owned; much of it is held in large blocks by mining companies or other owners closely associated with the mining industry. This is particularly true in West Virginia and Kentucky. For example, in WV-1 a single owner holds title to 41 percent of the entire acreage in the CPA (*45*). Despite the concentration in ownership in some areas, a recent study shows that "by conventional standards, Appalachian coal production is highly competitive," and that there is little likelihood of anticompetitive behavior in the industry (*61*).

The Pacific Region is a special case, consisting as it does of CPA's in Washington and Alaska with widely different ownership patterns. Virtually all the coal in Alaska is owned by public agencies, but ownership patterns are still in flux so the extent of State or tribal coal cannot be determined. In the Washington CPA's, there are large amounts of Federal land, and one coal lease is in effect (*94*). However, there has been no coal production from Federal land in Washington, and no KRCRA's were established; therefore, no data are available to show the extent of Federal coal.

Coal Leasing

Ownership of the mineral estate—coal in this case—usually carries with it the right to explore the resource and mine it. These rights are often conveyed to another party, typically a mining company, by means of a lease. Leasing of coal rights by private owners is common, and it has been the subject of some abuses and much public comment and criticism.[28] The extent of coal leasing from private owners, and the extent to which surface and mineral rights are held separately on private land, is a subject on which little statistical evidence is available. This is because public records are mostly kept at the county level, the form and the degree of detail required vary from State to State, and there is no general requirement for consolidating them. A full description of the problem associated with coal leasing of private lands has been treated elsewhere (*35, 42*).

Leasing of Federal coal, on the other hand, has been the subject of much public debate, legislative action, and litigation, so there are compelling reasons for making data available to the public to show the nature and extent of the practice. The Bureau of Land Management (BLM) has primary responsibility for leasing Federal mineral land and for keeping the relevant records. In 1970, a BLM study of leasing found that the leasing of coal land had increased sharply since 1945 but that production from Federal leases had decreased substantially (*96*). Many people viewed the results of this study as proof of unwarranted speculation in Federal coal leases. In 1971, the BLM established a moratorium on leasing, and as a result of this and subsequent actions, no Federal leasing has occurred since, except for a few special cases. In 1978, the BLM released a Draft Environmental Statement describing a new Federal Coal Management Program, and in April 1979, the final statement was released (*96*). This document not only describes the new program but also gives

[28] See, for example, (*45*) and (*58*).

Table 17—Land and coal ownership patterns in Known Recoverable Coal Resource Areas (KRCRA's)

Region and Coal Production Area	Federal coal: surface ownership is—					Non-Federal coal: surface ownership is—					Total area of KRCRA[3]	Ratio: Federal coal to area of KRCRA
	Federal[1]	Private	State	Indian[2]	Total[3]	Federal[1]	Private	State	Indian[2]	Total[3]		
	1,000 acres											*Percent*
Northern Great Plains Region:												
MT-1	–	–	–	–	–	–	–	–	–	–	–	–
MT-2	25.6	240.9	7.3	–	273.8	5.5	331.1	39.0	–	375.7	649.5	42.2
MT-3	5.7	179.8	3.4	–	188.8	–	222.4	23.9	–	246.3	435.1	43.4
MT-4	155.9	545.2	11.1	–	712.2	.1	244.2	61.1	1.1	306.6	1,018.7	69.9
MT-5	481.6	509.9	10.1	–	1,001.6	7.2	219.8	50.4	–	277.5	1,279.1	78.3
ND-1	.5	48.3	.4	–	49.3	.4	119.4	4.3	–	124.1	173.3	28.4
ND-2	29.5	373.6	2.6	–	405.7	15.1	883.7	30.8	–	929.7	1,335.4	30.4
ND-3	53.6	303.9	.6	–	358.0	10.7	686.4	14.5	–	711.5	1,069.5	33.5
SD-1[4]	–	–	–	–	–	–	–	–	–	–	–	–
WY-0	.4	.3	–	–	.7	–	.7	.1	–	.8	1.5	–
WY-1	55.5	632.2	10.6	–	698.3	1.2	110.5	164.6	–	276.4	974.6	71.6
WY-2	349.3	1,625.4	11.5	–	1,986.2	20.4	130.4	156.3	–	307.1	2,293.3	86.6
WY-3	221.1	217.9	1.4	–	440.3	14.8	178.7	32.1	–	225.6	665.9	66.1
WY-4	1,031.7	347.6	3.8	–	1,383.1	.8	769.8	69.2	–	839.8	2,222.9	62.2
Total NGP[3]	2,410.3	5,025.0	62.7	–	7,497.9	76.2	3,897.2	646.4	1.1	4,620.9	12,118.9	61.9
Rocky Mountain Region:												
AZ-1[5]	–	–	–	–	–	–	–	–	–	–	–	–
CO-1	104.1	301.5	.6	–	406.3	4.4	104.3	45.6	–	154.3	560.6	72.5
CO-2	19.2	5.0	2.6	–	26.9	.2	15.1	4.6	–	20.0	46.9	57.4
CO-3	–	–	–	–	–	–	–	–	–	–	–	–
CO-4	282.9	158.3	–	–	441.2	2.7	49.7	3.6	–	56.0	497.2	88.7
CO-5	83.6	58.6	2.9	–	145.0	3.3	76.8	22.2	1.1	103.4	248.5	58.4
CO-6	–	–	–	–	–	–	–	–	–	–	–	–
CO-7	.6	94.8	1.2	–	96.6	–	349.0	28.6	–	377.5	474.2	20.4
NM-1	848.0	130.8	13.3	273.1	1,265.2	24.6	88.0	103.4	82.4	298.3	1,563.5	80.9
NM-2	422.2	62.8	10.3	59.6	554.9	9.7	10.3	34.4	49.3	103.7	658.6	84.3
NM-3	–	–	–	–	–	–	–	–	–	–	–	–
NM-4	11.2	11.0	.6	1.6	24.5	–	.1	.6	–	.7	25.2	97.2

Continued –

See notes at end of table.

Table 17—Land and coal ownership patterns in Known Recoverable Coal Resource Areas (KRCRA's)—Continued

Region and Coal Production Area	Federal coal: surface ownership is—					Non-Federal coal: surface ownership is—					Total area of KRCRA[3]	Ratio: Federal coal to area of KRCRA
	Federal[1]	Private	State	Indian[2]	Total[3]	Federal[1]	Private	State	Indian[2]	Total[3]		
	1,000 acres											*Percent*
UT-1	247.2	76.2	4.3	–	327.7	1.1	86.3	11.9	–	99.3	427.0	76.7
UT-2	588.1	29.2	.4	–	617.7	4.3	12.7	54.5	–	71.4	689.1	89.6
UT-3	–	–	–	–	–	–	–	–	–	–	–	–
Rocky Mountain total[3]	2,607.2	928.1	36.4	334.2	3,905.9	50.2	792.3	309.4	132.8	1,284.7	5,190.6	75.2
Total, two Western Regions[3]	5,017.5	5,953.1	99.0	334.2	11,403.9	126.4	4,689.5	955.8	133.9	5,905.6	17,309.5	65.9
Percentage	29.0	34.4	.6	1.9	65.9	.7	27.1	5.5	.8	34.1	100.0	N.A.

– = None.
N.A. = not applicable.
[1] Includes Public Domain (administered by the Bureau of Land Management), National Forests, National Grasslands, land withdrawn for special purposes, and all other Federal lands.
[2] Mostly Indian Trust land located outside the established boundaries of Indian reservations. Land within Indian reservations is not included in any of the KRCRA's. Thus, extensive acreages of coal reserves owned by Indians are not included in this table, especially in AZ-1, NM-1, and MT-4.
[3] Data may not add to total because of rounding.
[4] No KRCRA's were established in South Dakota because no coal development is expected.
[5] No KRCRA's were established in Arizona, although there are large reserves and two large mines on the Navajo reservation in AZ-1.

Source: (*97*); see also (*96*).

a history of the various legislative actions, executive orders, and court decisions affecting coal leasing up to 1978.

As part of the data used in developing the Federal Coal Management Program, the BLM presented statistics on leases of Federal coal in the KRCRA's. In the six western coal states, there were about 11.4 million acres of Federal coal. Of this, about 585,000 acres, or 5 percent, were under lease in 1978 (table 18). The largest acreage under lease was in Utah and Wyoming. In addition, nearly 335,000 acres of land were under preference-right lease applications. Where granted, these applications permit exploration and carry the right to lease the coal if commercial deposits are discovered. There are more acres under preference-right lease applications in Wyoming than in any other State. Most of the remaining preference-right application acres are in New Mexico and Utah. There are none in North Dakota. The coal land not yet leased ranges from 68 percent of all Federal coal land in Utah to 98 percent in Montana and North Dakota.

Although the United States is the dominant owner of reserves in the six western States, more than half the production comes from non-Federal coal land. In 1977, production from Federal leases was 51.6 million tons, or 44 percent (table 19). The largest production from Federal leases was in Wyoming—28.3 million tons or 62 percent of the State total. The smallest amount of coal from Federal leases was in North Dakota. There appears to be a trend toward more production from Federal leases. In 1957 the "Federal share" was 28 percent; in 1962 it climbed to 35 percent; then it dropped off to a low of 20 percent in 1972. Since then, the Federal share has increased, reaching 44 percent in 1977.

Land Use

Land use patterns in the CPA's are so varied that attempting to describe a "typical" land use is impractical. In the aggregate, most of the land area of the CPR's is farmland—194 million acres out of 329 million acres in 1974 (table 20).[29] Most of the farmland is pasture, range, woodland, and other (120 million acres), while cropland amounts to 74 million acres. Such gross figures, however, tend to cover up fundamental differences, not only between regions, but be-

[29] In this section, all statistics on agriculture are from the 1974 Census of Agriculture, the latest available source of data by county. Although the information is outdated, it is accurate enough for valid comparisons between CPR's and CPA's.

Table 18—Federal coal leases in Known Recoverable Coal Resource Areas (KRCRA's), 1978

State[1]	Federal coal land in KRCRA's					Non-Federal coal area[3, 7]	Total area of KRCRA[4]
	Areas leased[2]	Preference-right lease applications[2]	Unleased area[3]	Total Federal coal land[4, 5]	Percent unleased[6]		
	1,000 acres				*Percent*	*1,000 acres*	
Montana	36.1	3.7	2,136.7	2,176.4	98.2	1,206.0	3,382.4
North Dakota	14.8	0	798.2	813.0	98.2	1,765.2	2,578.2
Wyoming	189.2	139.4	4,180.0	4,508.6	92.7	1,649.7	6,158.2
Total, Northern Great Plains[4]	240.1	143.1	7,114.8	7,497.9	94.9	4,620.9	12,118.9
Colorado	82.3	39.2	994.6	1,116.0	89.1	711.3	1,827.3
New Mexico	41.0	78.0	1,725.5	1,844.5	93.5	402.7	2,247.2
Utah	221.7	74.6	649.1	945.4	68.7	170.7	1,116.1
Total, Rocky Mountain	345.0	191.7	3,369.2	3,905.9	86.3	1,284.7	5,190.6
Total, Western Region	585.1	334.8	10,484.0	11,403.9	91.9	5,905.6	17,309.5

[1] Data on leasing are not available by CPA's.
[2] From U.S. Bureau of Land Management (*97*).
[3] Column 4 minus columns 1 and 2.
[4] Data may not add to total because of rounding.
[5] From table 17.
[6] Column 3 divided by column 4 times 100.
[7] Includes State, Indian, and private ownership.

tween CPA's within regions, and even within the CPA's themselves.

The land in the Interior Region, consisting of 73 million acres, is mostly in farms; most of this farmland is cropland, and most of the cropland is harvested. No other CPR has such an intensive use pattern for its agricultural land. There are significant differences within the region. IL-1, IL-2, IL-3, IL-4, and IA-2 all have more than 75 percent of the land area in farms; more than 75 percent of the farmland is cropland, and more than half the land area was cropland harvested (app. tables 5 and 6). These five CPA's are outstanding because the soil and topography are eminently suited to agriculture, especially row crops such as corn and soybeans. In AR-1, however, only one-third of the land is in farms, and less than one-fifth of the farmland is used for harvested crops. Again, the reasons are soil and topography. A large part of AR-1 is in the Ozark Mountains, an area unsuited to large-scale crop production.

The Northern Great Plains Region is second to the Interior in land use intensity. More than 80 percent of the land is in farms but nearly 75 percent of the farmland is pasture and range; only about 13 percent of the land area is harvested cropland (table 21). Again, the averages for the region cover up some significant differences between CPA's. The three North Dakota CPA's and MT-1 have relatively more cropland than any of the others. Most of the land in Wyoming CPA's and in MT-3, MT-4, and MT-5 is used for pasture and range.

Table 19—Coal production from Federal leases, six Western States[1]

Region and State	Coal production		
	Total	From Federal leases	Federal leasing share
	Million tons		*Percent*
1957 Six States	15.7	4.4	28
1962 Six States	14.0	4.9	35
1967 Six States	21.2	6.5	31
1972 Six States	44.4	8.8	20
1973 Six States	53.3	12.9	24
1974 Six States	64.4	21.5	33
1975 Six States	78.3	31.0	40
1976 Six States	95.3	38.1	40
1977 Six States	116.9	51.6	44
Montana	27.2	10.5	39
North Dakota	12.0	.7	6
Wyoming	46.0	28.3	62
Northern Great Plains Region	85.2	39.5	46
Colorado	12.0	4.0	33
New Mexico	11.1	2.3	21
Utah	8.6	5.8	67
Rocky Mountain Region	31.7	12.1	38

[1] States identified under 1977 entry.

Sources: (*90; 96*, tables 2-8 and 2-9; *103; 105*).

The Eastern and Pacific Regions have the least farmland of any; 26 percent and 12 percent, respectively, of the land area is in farms. Much of the Eastern Region is within the area commonly called Appalachia, where the terrain is mostly mountainous, with relatively little land suitable for any kind of farming. In some CPA's, such as KY-4, KY-5, and WV-5, less than 15 percent of the land area is in farms. In all the CPA's in Kentucky, West Virginia, Tennessee, and Virginia, very little is cropland and much of this is used only for pasture, suggesting that its agriculture is far from intensive.

The Pacific Region, consisting of CPA's in Washington and Alaska, is difficult to characterize. Large parts of the CPA's in Washington are included within the Cascade Mountain range, although the land in a few areas of considerable size is well suited to agriculture. Much of the cropland depends on irrigation, especially in the eastern portion of WA-2, where the climate is arid. The Alaska portion of the region is cold and is ill-suited to any type of agriculture; hence, there is little farmland, and only a small part of it is used for harvested crops.

Crops Produced

The kind of crops produced in any area is a function of climate, soil, and topography; and the cropping pattern shows the intensity of land use. In the Northern Great Plains, wheat is by far the most important crop; it accounts for 55 percent of the cropland harvested in that region and leads all other crops in seven of the CPA's (table 22 and app. table 7). Hay is next in acreage with 28 percent; it is the leading crop in six CPA's and second in acreage in six others. The third crop in acreage is small grains. In every CPA the three leading crops are wheat, small grains, and hay—although not necessarily in that order.

The Rocky Mountain Region has a wider variety of crops. Hay has the largest acreage—38 percent—followed by wheat with 35 percent and corn with 13 percent. Most of the wheat is grown on dry land in northeastern Colorado (CO-7),

Table 20—Land area and major land use in Coal Production Areas (CPA's), 1974[1]

Region	Land Area	Nonfarm land	Land in farms							
			Cropland				Woodland	Pasture, range, and other	Total	Irrigated
			Harvested	Pasture	Other	Total				
	1,000 acres									
Northern Great Plains	77,003	14,846	9,922	1,590	5,641	17,152	910	44,095	62,157	660
Rocky Mountain	90,728	42,896	1,991	762	926	3,679	6,090	38,063	47,832	1,436
Interior	73,014	16,673	31,500	7,694	1,707	40,900	5,064	10,377	56,341	78
Eastern	56,943	41,980	3,744	3,026	572	7,342	4,678	2,944	14,964	9
Gulf	24,476	12,325	1,510	2,952	269	4,730	2,806	4,616	12,152	78
Pacific[2]	7,286	6,380	197	134	13	344	171	391	905	114
Total, all CPA's[2]	329,450	135,099	48,864	16,158	9,128	74,147	19,719	100,486	194,351	2,375
	Percent of total acres									
Northern Great Plains	100	19.3	12.9	2.1	7.3	22.3	1.2	57.3	80.7	0.9
Rocky Mountain	100	47.3	2.2	.8	1.0	4.1	6.7	42.0	52.7	1.6
Interior	100	22.8	43.1	10.5	2.3	56.0	6.9	14.2	77.2	.1
Eastern	100	73.7	6.6	5.3	1.0	12.9	8.2	5.2	26.3	–
Gulf	100	50.4	6.2	12.1	1.1	19.3	11.5	18.9	49.6	.3
Pacific[2]	100	87.6	2.7	1.8	.2	4.7	2.3	5.4	12.4	1.6
Average[2]	100	41.0	14.8	4.9	2.8	22.5	6.0	30.5	59.0	.7

Note: Data may not add to total because of rounding.
– = Less than 0.05 percent.
[1] For detail by CPA, see appendix table 5.
[2] Excludes Alaska.

Source: (*84*).

Table 21—Land use ratios for Coal Production Areas (CPA's), regional averages, 1974[1]

Region	Farmland to land area	Cropland to farmland	Harvested cropland to total cropland	Harvested cropland to land area
	Percent			
Northern Great Plains	80.7	27.6	57.8	12.9
Rocky Mountain	52.7	7.7	54.1	2.2
Interior	77.2	72.6	77.0	43.1
Eastern	26.3	49.1	51.0	6.6
Gulf	49.6	38.9	31.9	6.2
Pacific[2]	12.5	37.9	57.3	2.7
All CPA's average[2]	59.0	38.2	65.9	14.8

[1] For detail by CPA, see appendix table 6.
[2] Excludes Alaska.

Source: (*84*).

whereas most other crops require irrigation. Hay is the leading crop in all but two of the CPA's in the Rocky Mountain Region, and a large part of it is irrigated alfalfa. Corn is second in acreage in six of the CPA's and third in three. Other crops of importance include small grains, sorghum, dry beans, and vegetables.

Most CPA'S of the Interior Region are located within the Corn Belt, where corn is the leading crop, with 40 percent of the harvested acreage. Soybeans are next with 36 percent. Corn and soybeans together are the two most important crops in 14 of the 24 CPA's, including all those in Illinois, Indiana, and Iowa as well as KY-1, MO-2, and MO-3. Hay, sorghum, and wheat are among the leading crops in some of the CPA's.

Throughout the Eastern Region, hay is the dominant crop, at least in acreage. Hay is first and corn is second in acreage in each of the CPA's, except AL-1, where corn is first. Small grains, wheat, or tobacco are third in acreage in most of the CPA's. The economic importance of tobacco is greater than indicated by the acreage figures because of its high value per acre.

Hay, sorghum, and corn are the leading crops in acreage in the Gulf Region. Cotton is third in acreage in three CPA's, namely, AR-2, TX-1, and TX-3, but it probably ranks higher than third in economic importance because of its relatively high returns per acre.

Hay is by far the leading crop in the CPA's of the Pacific Region, with about 72 percent of the total acreage. Vegetables are important in the Washington CPA's. The climate of Alaska is so severe that only short-season crops are grown, including hay, small grains, and potatoes.

Farm Income

The gross value of farm products sold is used here as an indicator of income potential.[30] We recognize that net income might be a more appropriate measure, but such data are available only at the State level.[31] In all six regions, the aggregate farm income was $10.9 billion in 1974, divided about equally between crops and livestock (table 23). About 66 percent of the income in the Northern Great Plains and Interior Regions was from crops; in each of the other regions, about 75 percent was from livestock. Nearly two-thirds of the total, $6.8 billion, was from the Interior Region, while the Eastern Region produced $1.3 billion.

Nearly all the income—98 percent—came from "commercial farms," defined for this report as those with more than $2,500 gross income.[32] The average income per farm ranged from $23,717 in the Eastern Region to almost $80,000 in the Rocky Mountain Region.

Agricultural intensity can be measured by the average value of farm income per acre. The Interior was the most intensive region with $92.84 per acre of land area or $120.31 per acre of farmland. The least intensive, by either measure, was the Rocky Mountain Region.

[30] The term "farm" is used in its broad sense to include livestock ranches.

[31] For convenience the term "income" is used in this section, but with the understanding that it represents gross sales of farm products.

[32] The term "commercial" is used here for convenience only; it is not intended to suggest that all farms in the group are capable of supplying agricultural products for market in "commercial" quantities.

Table 22—Three leading crops in each Coal Production Region, 1974

Region	Cropland harvested[1]	First		Second		Third	
	1,000 acres	*Crop*	*Percent*	*Crop*	*Percent*	*Crop*	*Percent*
Northern Great Plains	9,922	Wheat	55.2	Hay	28.2	Small grains[2]	14.3
Rocky Mountain	1,991	Hay	38.2	Wheat	34.8	Corn	12.6
Interior	31,500	Corn	40.4	Soybeans	36.2	Hay	11.1
Eastern	3,744	Hay	50.7	Corn	29.0	Small grains[2]	8.1
Gulf	1,510	Hay	41.2	Sorghum	15.6	Corn	11.7
Pacific	214	Hay	71.9	Vegetables	10.6	Corn	5.4

[1] Data may not add to total because of rounding.
[2] Small grains include oats, barley, rye, and mixed grains.

Source: (*84*).

Some important interregional variations are hidden by the averages in table 23. In the Northern Great Plains, 8 of the 13 CPA's had more income from livestock than from crops, although about 41 percent of the regional average was from livestock (app. table 8). In one CPA, ND-1, crop income was $241 million, which is more than four times the livestock income, and it represents about 41 percent of the total crop income of the region. ND-1 also had the most intensive agriculture in the region, $30.78 gross income per acre. The lowest intensity was in the four Wyoming CPA's and the two westernmost CPA's in Montana, all of which had less than $10 income per acre.

The Rocky Mountain Region also had wide variations from one CPA to another. CO-7 had a total income of $726 million, which was 75 percent of the regional total. The average income was nearly $98 per acre and $145,000 per farm. Most of this high income in CO-7 was from Weld County, where there are many large cattle-feeding operations, at least one of which is noted for its size and high degree of vertical integration.

In all the other CPA's, the income per acre was relatively low, ranging from $0.67 in UT-2, and $1.03 in AZ-1 to $5.33 in CO-2 and $8.15 in CO-4. In AZ-1, NM-1, and NM-2, much of the land is in Indian reservations and is largely devoted to extensive livestock grazing. Reservations are counted as "farms" by the Census, but they are classified as "abnormal" and not included with the "commercial" farms. In these three CPA's, the "other" farms were much larger than in other CPA's (both in acreage and income) because the group included the "abnormal" farms.[33]

Income in the CPA's of the Interior Region was much more uniform and substantially larger than in the other regions. Income per acre was much higher than in any other region; in fact, income per acre in the three lowest-income CPA's in the Interior (the three in Oklahoma) was higher than in most CPA's in other regions. All the CPA's in Illinois, Indiana, and Iowa had higher income per acre than any other, except CO-7. Crop income was larger than livestock income in most of the CPA's, including all those in Illinois and Indiana.

Income per farm exceeded $44,000 in AL-1 and was the highest of any CPA in the Eastern Region.[34] Next was PA-2 with over $31,000. The lowest were WV-4 with $6,670 and KY-3 with $9,564. Average income per acre was $49 in OH-1; next was PA-1 with almost $26. The lowest income per acre was in KY-4 and KY-5, but WV-4, WV-5, and WV-6 were all less than $5 per acre. In each CPA in the latter group, less than a third of the places classified as farms are commercial farms by the definition used here, and less than 20 percent of

[33] "Abnormal" farms, so called by the Census because they bear little resemblance to the typical family farm in management or organization, include experimental farms and institutional farms as well as Indian reservations.

[34] In AL-1, 82 percent of the livestock income was from large poultry farms; in one county in AL-1, 91 percent of the income was from poultry.

Table 23–Gross farm sales: Total, per farm and per acre, by region, 1974

Region	From livestock	From crops	Total	Commercial farms	Other farms	Income per commercial farm	Average per acre of–	
							Land	Farmland
	1,000 dollars					*Dollars*		
Northern Great Plains	407,948	590,742	998,693	994,988	3,705	40,552	12.97	16.07
Rocky Mountain	731,879	235,165	967,047	942,930	24,117	79,950	10.66	20.22
Interior	2,676,441	4,102,238	6,778,673	6,718,930	59,743	39,069	92.84	120.31
Eastern	922,592	350,324	1,272,902	1,207,868	65,034	23,717	22.35	85.07
Gulf	476,607	158,726	635,334	604,887	30,447	28,441	25.96	134.32
Pacific	153,139	52,217	205,360	201,871	3,489	55,689	[1]27.30	[1]219.80
Total or average	5,368,606	5,489,412	10,858,009	10,671,474	186,535	37,559	[1]32.94	[1]55.83

[1] Excludes Alaska.
Data may not add to total because of rounding.

Source: (*84*).

these have gross incomes of $20,000 or more (*84*). Most of the people living on farms in this area had some source of off-farm income; those who do not are likely to be living below the poverty level. This low level of agricultural income is due primarily to lack of resources; the topography is mountainous and little land is level enough to be suited for crop production.

Farm income in the Gulf Region and the Washington portion of the Pacific Region averages $26 and $27 per acre, respectively, and not as much variation occurs between CPA's as in other regions. Alaska, however, has so few farms and so much nonfarm land that the income per acre of land area was very low; it varied from 1 cent to 12 cents per acre. The gross income per farm ranged from about $12,000 in AK-4 to nearly $42,000 in AK-3. There were no farms in AK-1, as it is too far north for successful production of even the hardiest crops.

Competition for Land Resources

A concern frequently expressed in connection with coal development is the effect of strip mining on the supply of farmland, sometimes coupled with the fear that continued increases in strip mining might jeopardize the national (or world) food supply. In this section, we attempt to assess the effect of expected increases in surface mining of coal on land use and farm production. To do so, however, we must make numerous assumptions as to the nature and magnitude of future events and the impact of these events on the resource base.

The obvious starting place, but perhaps the most difficult, is projecting the amount and location of surface mining activity. One way to project coal production is to aggregate the future plans of mining companies. By combining data from several sources, we projected average annual coal production from strip mines for 1975-99 (*7, 44, 92*). These projections represent actual production data for 1975-77,[35] estimated production for 1978-79,[36] and expansion intentions for 1980-99. Results show an annual average of 746 million tons to be produced by strip mining for the period, with 296 million tons (or 40 percent) from the Northern Great Plains (table 24). The Eastern Region would be second with 205 million tons or about 27 percent of the total. Among the CPA's, two are outstanding in projected production, and both are in the Powder River Basin; they are WY-2 with 142 million tons and MT-4 with 58 million tons (app. table 9). Three other CPA's are worthy of mention—PA-2 with 41 million tons, TX-1 with 34 million tons, and KY-1 with 32 million tons. These five CPA's would account for 41 percent of the total strip-mined coal in the United States during the 25 years.

Concerning the above projections, two points are worth noting. First, there are a few CPA's with substantial strippable reserves where little or no strip mining is projected, for example, MT-2, MT-5, AL-2, and AK-1. Second, in some CPA's, the average annual projected production is much larger than current production, which suggests substantial growth during the period. Such is the case in WY-2, MT-4, and some others.

The next step is to establish a relationship between coal production and land use. In strip mining there is a consistent inverse relationship between seam thickness and acreage actually mined. This relationship may be expressed as coal yield per acre, which ranges from 2,000 tons or less in some CPA's in Kansas and Oklahoma to more than 100,000 tons in WY-2, where coal seams are sometimes 100 feet thick and the average for the CPA is 71 feet.[37] Regional averages, which only generally indicate relative coal yield, range from about 5,000 tons per acre in the Interior and Eastern Regions to 47,870 tons per acre in the Northern Great Plains Region. To produce a million tons of coal from a seam of average thickness in WY-2 would require 9.9 acres, whereas in AR-1, AL-1, or KS-3, it would take 333 acres.[38] These calculations show the amount of land disturbed to produce a given amount of coal, but to estimate the impact on agriculture, one must account for the fact that each acre disturbed will be out of production until the land is reclaimed and restored to use. Although authorities are not fully agreed as to the length of time required for land reclamation, they assume the time would be longer in areas of low precipitation than in more humid areas (*22, 41, 52*). In computing the data in tables 24 and appendix table 9, we arbitrarily assumed that 10 years would be required in the Rocky Mountain Region, 8 years in Montana and Wyoming, and 5 years in all other areas.

In addition to the land disturbed by the mining process, each mine needs land for permanent facilities, such as coal storage and loading areas, parking lots, shops, offices, roads, and in some cases, railroad spurs or loops. We assume that land used for such purposes is not reclaimed but remains out of production for the entire study period. Data on the area required for such facilities are fragmentary and generally inconsistent, so it was necessary to make an arbitrary allowance. For each new or expanded mine, we assumed 800 acres for the Northern Great Plains, Rocky Mountain, and Pacific Regions, 600 acres in the Interior and Gulf Regions, and 400 acres in the Eastern Region.

[35] Data by counties were available for 1975-77, so production by CPA's could be obtained by a simple process of aggregation (*44*).

[36] Available by States, but not by counties (*90*).

[37] The data used here are averages for each CPA and are based on a recovery factor of 80 percent. In practice, the recovery factor may exceed 80 percent in the thick seams.

[38] One million divided by coal yield per acre.

The resulting calculations from all the above assumptions indicate an annual average of 568,300 acres would be out of production during 1975-99, the assumed period of analysis.[39] The largest acreage would be in the Eastern Region, about 225,000 acres. In the Interior Region, about 132,000 acres would be out of production annually. The largest such acreage in any CPA is 45,500 acres in PA-2; AL-1 is next with 32,800 acres, and KY-1 is third with 31,880 acres.

Expressing such losses of land in dollars enables one to gain more perspective in judging their significance. To do this, we assume that in every CPA land used for mining is equal to the average of the CPA and that its production can be expressed as annual gross farm sales per acre of land area, as shown in table 24 and appendix table 9. Thus, the value of farm production displaced in all the CPA's would be about $16 million a year, of which nearly $10 million would be in the Interior, about $4 million in the Eastern, and less than $1 million in each of the other regions (1974 prices are assumed). There are six CPA's where the loss would be more than $1 million dollars annually; collectively this group of six accounts for $9.4 million, or 58 percent of the total. Two of the high CPA's are in Illinois; there is one each in Indiana, Kentucky, Ohio, and Pennsylvania. These CPA's as a group have three common characteristics; they produce large amounts of coal, the coal seams are thin (relative to the western CPA's), and the value of farm production per acre is relatively high. Two of the western CPA's (MT-4 and WY-2) are expected to produce much more coal than any of the above six, but the value of farm production displaced is low in the West because coal yield per acre is high and the value of farm production per acre is relatively low.

Comparing production displaced with the value of normal farm output in the study area is another way to gain perspective. The value of all farm production in the six regions was about $10.9 billion. The production displaced in the same area is only $16 million, or 0.15 percent of the total. The largest relative loss of productivity is in the Eastern Region—0.33 percent. In the Northern Great Plains, where coal produced from strip mining is largest, the loss of farm production is only 0.09 percent of the total. In a few CPA's, however, the ratio is much higher, especially in KY-4 (1.41 percent), KY-5 (1.17 percent), IN-2 (0.87 percent), and KY-1 (0.83 percent). In the two Kentucky CPA's, the ratio is high because there is relatively little farmland; hence, the productive base is low, and to lose even a little farm production results in a higher ratio.

[39] This would be acreage in addition to that disturbed in years prior to 1975 and includes future land use for old mines as well as for new and expanded ones.

Table 24—Projected coal production from surface mines, land used for mining, and value of farm production displaced, 1975-99

Coal Production Region	Average annual coal production, 1975-99	New or expanded mines	Coal yield per acre[1]	Average annual land acreage used for coal production	Annual value of production displaced		Ratio[2]
					Per acre	Total	
	Million tons	*Number*	*Tons*	*1,000 acres*	*Dollars*	*1,000 dollars*	*Percent*
Northern Great Plains	296	66	47,870	103.6	9.06	939	0.09
Rocky Mountain	66	27	16,280	66.9	2.76	185	.02
Interior	116	30	5,040	132.6	73.64	9,762	.14
Eastern	205	34	5,520	225.9	18.65	4,212	.33
Gulf	58	12	[3] 10,220	37.8	26.32	995	.16
Pacific	6	2	[4] 31,150	1.6	22.52	35	.02
Total/average	746	171	na	568.3	28.38	16,128	.15

na = Not available.
[1] Average for all strippable reserves in the region.
[2] Value of production displaced as a percentage of all farm production in the CPA's of the region.
[3] Includes Texas only.
[4] Includes Washington only.

Source: Appendix table 10.

Strip mining of coal is not a serious threat to food supplies from a national or regional viewpoint, if the assumptions used in our analysis are reasonable. Neither is there any serious reduction in aggregate farm output in any given CPA, particularly not in those where a strong farm economy exists. Two caveats are in order, however. First, we assumed that the land used for mining was equivalent in productive capacity to the average acre in the CPA, not the average for farmland. If all or most of the mining in a particular CPA were to take place on farmland alone, the resulting estimates of value would likely be much higher, especially where the ratio of farmland to land area is relatively low, as in the Eastern Region. Second, even though the loss of farm productivity is relatively insignificant in the aggregate, it may be highly significant to a particular landowner or a local community. The person who loses a major part of his or her farm to a strip mine might find little consolation in the knowledge that the average loss for the CPA was an insignificant percentage, particularly if he or she believes that the reimbursement received for disturbing his or her operations is inadequate. Although it is important to recognize that the aggregate agricultural losses to strip mining are insignificant at the national or regional level, it is also true that local losses may be serious, and the impacts on a few farms may be severe.

Water

Coal development is sometimes regarded as a threat to water supplies, in terms of quantity or quality or both. Competition for water with other kinds of development varies greatly within and between regions. Water supplies may be affected in a number of ways. Water use is measured in two ways, either by the amount diverted from a stream or an aquifer, or by "consumptive use," the amount consumed or "used up" by the activity or facility in question. Consumptive uses include cooling and boiler water for coal-fired electric generators, water used as feedstock for coal gasification, and water used in the mining processes. Slurry pipelines transfer water from one location to another, probably outside the basin of origin. Thus, the effect would be similar to a consumptive use as far as the basin is concerned. Changes in water quality occur from acid mine drainage, from thermal pollution which results from discharge of cooling water, and from the impurities remaining after the coal from a slurry pipeline is dewatered. Water supplies could be destroyed or interrupted when a strip mining operation blocks or alters the course of a stream, cuts through an aquifer, or destroys one. In many locations the coalbed itself may be an important aquifer.

The manner in which coal development affects water supplies is site-specific, and the severity of the resulting competition for water supplies varies tremendously from one area to another. Thus, most research on the impact of coal development on water supplies has been regional or local. One significant exception is "A Nationwide Assessment of Water Quality Impacts on the National Energy Plan" (NEP), a study conducted at the Oak Ridge National Laboratory (*16*). The principal conclusion was that, by 1985, the aggregate impact of all projected energy development, including coal, will increase consumptive water use by less than 1 percent of the U.S. water supply (fig. 7).[40] Although this conclusion is generally valid, it tends to cover up some important regional water problems associated with coal development, which we discuss below.

The actual quantity of water required for any particular coal conversion facility depends greatly on a number of site-specific variables, and in most cases, the amount of water withdrawn from the stream greatly exceeds the amount of consumptive use. Some generalizations are possible, however. The Nationwide Assessment used the following estimates of water withdrawn and consumed in projecting annual water requirements (*16*, except as noted):

Method	Water quantity	
	Withdrawn	Consumptive use
	Acre-feet	
Thermogenerators, 1,000 MW:[1]		
Once through cooling	930,800	4,500
Cooling pond	29,100	17,900
Wet cooling tower	20,200	12,300
Dry cooling tower	1,300	1,100
Coal gasification, 250 MMcfd[2]	21,300	17,900
Coal liquifaction, 50,000 bbl/day	22,400	22,400
Slurry pipeline, 5 million tons[3]	3,000	not available

[1] Megawatts. A megawatt equals 1,000 kilowatts.
[2] Million cubic feet per day.
[3] From Yellowstone Level B Study (*47*, table 21).

Regional Water Supplies

In a few areas in Wyoming and Montana, and in most of the Colorado River basin, surface water supplies are so scarce that added competition for water from coal development could become a serious problem. However, in the East and Interior, new coal facilities would use only a small portion of available surface water supplies.

[40] The Aggregated Sub Areas (ASA) shown in figure 7 are those established by the Water Resources Council.

The Northern Great Plains Region. This region is characterized by low to moderate precipitation patterns, with wide variations from season to season, year to year, and place to place. Therefore, water supplies vary widely, both seasonally and geographically. Nearly all CPA's in the region are located in the basins of the Missouri River and its tributaries, the most important of which is the Yellowstone. An exception is ND-1, part of which is drained by the Souris River into Canada, and another is WY-4, most of which drains into the Green River and then into the Colorado.

The availability of water for energy development in the Northern Great Plains has been the subject of several studies in recent years (*23, 47, 56, 99, 110, 112*). These studies have generally indicated that there is plenty of water in the region to supply the needs of coal development but that problems of storage, transfers between sub-basins, or institutional barriers to water use may arise in local situations. Irrigation is by far the largest user of water in each of the river basins in the Northern Great Plains, accounting for nearly 5 million acre-feet (maf) out of a total of 7.5 maf (table 25). Thus, it follows that where conflicts for the use of water arise, agriculture will be one of the major claimants. Evaporation from large reservoirs is also important but cannot be controlled effectively with current technology. The remaining competing uses include municipal, industrial, and livestock watering, as well as energy development.

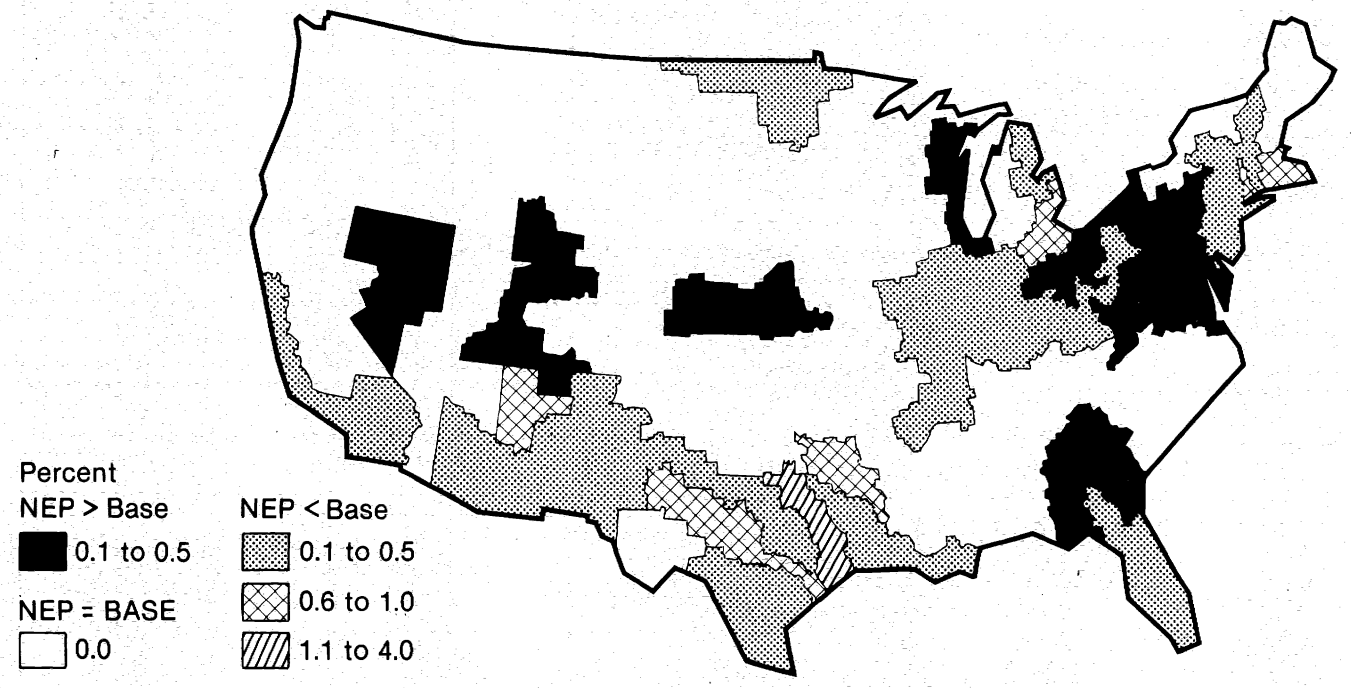
The "remaining flows" shown in table 25 are annual averages, whereas the controlling quantities are likely to be the lowest flows that could be reasonably expected during a water-short season (critical year flows). In addition, certain minimum instream requirements must be met to satisfy all claims to the flow of a given stream.[41] In several streams in the Northern Great Plains, the claimed instream requirements are substantially larger than the critical year flows. For example, in the Tongue and the Powder Rivers, the instream requirements claimed are more than three times the critical year low flows (table 26).

The most intensive coal development in the Northern Great Plains is likely to take place in two principal areas—in the Tongue-Powder Basins in Wyoming (WY-2 and MT-4) where water is short and in North Dakota on both sides of Lake

[41] The extent to which instream requirements can be enforced legally is still unsettled.

Figure 7

Water Resource Impacts of the 1977 National Energy Plan (NEP)



The water resource impacts of the National Energy Plan (NEP) are almost identical to the 1985 Base Case. Water consumption by all energy facilities as a percentage of the surface supply varies by less than 1 percent (of the supply) in every Aggregated Subarea except the Trinity River Basin in Texas (▨).

Table 25—Estimated level of streamflow depletions and remaining average annual flows, 1970

Depletion or flow	Upper Missouri	Yellow-stone	Western Dakota	Eastern Dakota	Main stem	Wyoming Platte[1]	Wyoming Green[1]	Total
	1,000 acre-feet per year							
Irrigation	1,480	1,987	427	256	0	577	242	4,969
Large reservoir evaporation	168	100	43	6	1,586	[2]179	[2]26	2,109
Other	124	87	105	64	0	20	28	428
Total depletions	1,772	2,174	575	326	1,586	777	296	7,505
Remaining flows	7,276	8,800	2,430	3,235	–	988	2,022	24,751

[1] Depletion levels and remaining flows in 1968.
[2] Includes evaporation other than that of large reservoirs.

Source: (*23*).

Table 26—Average annual flow of surface water remaining for use, 1970

River	Critical year flow	Average annual flow	Instream requirements
		Acre feet	
Yellowstone Basin:			
Clarks Fork	538,000	767,000	207,800
Wind Bighorn	1,429,000	2,550,000	1,527,600
Tongue	32,000	304,000	148,500
Powder	43,000	416,000	162,500
Yellowstone (near Sidney)	3,720,000	8,800,000	4,083,800
Upper Missouri Basin:			
Missouri at North Dakota Border	na	7,276,000	na
Missouri at Lake Sakakawea	na	16,952,000	na
Missouri at Oahe Reservoir	na	18,525,000	na
Western Dakota Territories:			
Little Missouri	35,000	390,000	184,800
Knife	3,000	118,000	61,700
Heart	17,000	154,000	70,000
Cannonball	1,000	149,000	68,300
Grand	9,000	156,000	44,800

na = Not available.

Source: (*55*, p. 13).

Sakakawea (ND-1 and ND-2) where water is plentiful.[42] In the former area, large quantities of water could be made available for energy development only by constructing more storage facilities or by interbasin transfers (*47, 56*). Fortunately, much of the coal produced in this area is expected to be shipped by rail to plants outside the region, so only a minimum amount of water will be required. Some coal companies plan to transport coal by slurry pipeline, in which case larger quantities of water will be required, and the water would be taken out of the basin of origin. Controversies over the right to use water in this manner will continue.[43]

Most of the new or expanded coal development in North Dakota is expected to take place near the main stem of the Missouri River where water can be obtained either from the river itself or from Lake Sakakawea (*99*). Thus, physical availability of water is not problem, although some institutional barriers may arise.

Rocky Mountain Region. The entire Rocky Mountain Region is water scarce—a fact likely to affect the rate of coal development. The principal drainage system in the region is the Colorado River, which drains all of Arizona, eastern Utah, western Colorado, and some of western New Mexico. Other drainage systems are the Missouri (northeastern Colorado), the Arkansas (southeastern Colorado and part of eastern New Mexico), and the Rio Grande (central part of New Mexico). The Great Basin, which includes western Utah, has no outlet to the sea.

The Colorado River Basin is peculiar because, although most of the water originates in the upper part, it is largely used in the lower part.[44] Estimating the future availability of surface water for potential energy development in any river basin is difficult because of institutionally imposed uncertainties, varying estimates of use (current and projected), and varying estimates of available supplies. Each of these uncertainties seems to be magnified on the Colorado River, which is one of the most difficult systems in any of the CPR's to analyze. Institutional factors which complicate analysis include the Colorado River Compact of 1922, which allocates 7.5 maf to the lower basin States; the Mexican Treaty of 1945, which guaranteed to Mexico an annual average of 1.5 maf; and the Upper Colorado River Compact of 1948, which provides the basis for dividing available water among the upper basin States (*59, 107, 108, 124*).

Another factor complicating the analysis is the difficulty of establishing just how much water is in the river and how much is available for current and future uses. One report states that:

> The original division of upper and lower basin allocations was based upon an assumed 10-year annual flow exceeding 18 maf. . . . However, as late as 1974 some agencies were using an assumed flow of 15 maf. . . . The U.S. Bureau of Reclamation has provided estimates ranging from 13.2 maf to 15.5 maf with a value of 14.1 maf being given as the most probable status.[45] . . . However, nature provided an average runoff of only 11.6 maf for the period 1954-63. This divergence between estimates sets bounds on water availabilities and also makes it apparent that individual states can easily arrive at differing estimates of their own water allocations. (*23*)

States do indeed arrive at differing estimates, and water supplies throughout the region have been the subject of continuing controversy. The issues are so complicated that they are beyond the scope of this report; suffice it to say that no agency can afford to assume that water could be made available for any specific coal development or facility. One set of projections of future flows and use (or depletions) shows that about three-fourths of the upper Colorado supply now flows out of the upper basin at Lees Ferry. Most of the depletions (2.1 maf out of 14.9 maf) go to Colorado, with small amounts to Utah and the other upper basin States (table 27). Of the lower Colorado supply, 14.3 maf, more than half goes to main stem depletions, much of which is used in California, while 5.4 maf (or about 38 percent) is used in Arizona. Only about 1 maf (or 7 percent) flows out of the United States to Mexico. Projected depletions for 2000 and 2020 could not be met because they would result in a "negative" outflow at the Mexican border, an obvious impossibility. Some of the projected claims will obviously be reduced or eliminated. The situation is confused further by the assumption that the Upper Colorado supply is indeed 14.9 maf. If it were only 13.3 maf, as suggested in the paragraphs we have quoted, there would be no current outflow to Mexico and a deficit of 0.6 maf would result. By the year 2020, the deficit would increase to 2.8 maf.

Most of the water supplies are now being used for irrigation, because crops in most of the region require irrigation water to supplement normal precipitation. In the Upper Colorado 74 percent of all stream depletion is used for irrigation, while in the Lower Colorado nearly 90 percent is thus used (table 28). Thermal electric power uses less than 2 percent of the total depletion in the upper basin and only 0.2 percent in the

[42] Lake Sakakawea is the reservoir formed by the construction of Garrison Dam on the main stem of the Missouri River.

[43] In the Yellowstone Level B study (*47*) it was assumed that, with high-level development, about 25 percent of the coal from the Tongue-Powder River areas would be transported by pipeline.

[44] The dividing point between the Upper and Lower Colorado is at Lees Ferry in Arizona near the Colorado border.

[45] This sentence refers to a 1975 report of the Bureau of Reclamation; see (*109*).

lower basin. Projections of future depletions are based on the expectation that most of the water will continue to be used for irrigation.

The foregoing strongly suggests that surface water for major energy projects will not likely be available except by diversion from other uses.[46] Because irrigation is the major use, it is likely that interests seeking water for energy will look toward agriculture as a potential source of supply. However, there are major institutional barriers, such as prior rights, water compacts, and international treaties, which would tend to prevent transfers from irrigation to energy development. There is a possibility, however, that ground water mining might become a means to overcome water deficits for some uses and in some areas (*23*).

[46] This statement applies to the whole region, although data for basins other than the Colorado are not presented here.

Table 27—Projected supply and depletions, Colorado River Basin

Location	Current[1]	1980	2000	2020
	Million acre feet (maf)			
Upper Colorado, virgin supply	14.9	14.9	14.9	14.9
Less depletions by:				
Arizona	*	.1	.1	.1
Colorado	2.1	2.4	3.1	3.1
New Mexico	.3	.5	.6	.7
Utah	.8	.9	1.1	1.2
Wyoming	.4	.5	.7	.7
Residual outflow, Lees Ferry	11.2	10.5	9.3	9.2
Plus virgin supply originating in the lower basin	3.1	3.1	3.1	3.1
Lower Colorado supply	14.3	13.6	12.4	12.3
Less depletions by:				
Arizona	5.4	6.2	5.9	6.4
Nevada	.3	.4	.5	.7
New Mexico	.1	.1	.2	.2
Utah	.1	.1	.1	.1
Main stem[2]	7.5	6.5	6.1	6.1
Residual outflow	1.0	.3	−.3	−1.2
Residual outflow, assuming Upper Colorado supply of 13.3 maf instead of 14.9 maf	−.6	−1.3	−1.9	−2.8

* = Less than 0.05 million acre feet.
[1] 1974-76 data.
[2] Exported from the basin.

Source: (*23*).

The Interior Region. The coal production areas of the Interior Region are in four river basins, each part of the Mississippi River system. The four basins are the Upper Mississippi, the Ohio, the Missouri, and the Arkansas-White-Red. According to the National Assessment of Water Quality Impacts (*16*), the average low flows of the Ohio and Upper Mississippi Rivers are more than adequate for all projected consumptive use for energy. Energy-related uses would consume a maximum of 6 percent of the low flow of any tributary of the Ohio River and a maximum of 5 percent in the Upper Mississippi. There is little need for concern about water availability in these two basins, except at specific sites. About 88 percent of the region's coal resources are located in these two river basins.

In the Missouri Basin supplies are less plentiful. and in years of low flow, some smaller streams may develop shortages for steam electric facilities. The same situation exists in the Arkansas-White-Red Basin, especially the western part. However, only a small part of the region's coal reserves are located in those two river basins; hence, development will be limited. Surface water supplies are not expected to hinder coal development in the region.

The Eastern Region. Surface water supplies are generally plentiful throughout the Eastern Region; it has been referred to as a "water rich" area. For current coal production and processing, there seem to be no shortages of surface water in any of the CPA's (*16*). At some future date, water supply problems might possibly emerge on streams such as the Allegheny or the Monongahela if all existing and proposed plants

Table 28—Colorado River depletions, by type[1]

Type	Upper Colorado		Lower Colorado[2]	
	Maf	*Pct.*	*Maf*	*Pct.*
Municipal and industrial	38	1.3	198	3.4
Thermal electric	50	1.7	10	.2
Minerals	48	1.6	52	.9
Fish and wildlife	36	1.2	110	1.9
Recreation	14	.5	4	.1
Livestock	53	1.8	[3]	[3]
Evaporation	520	17.8	230	4.0
Irrigation	2,159	74.0	5,226	89.6
Total depletions[4]	2,918	100.0	5,830	100.0

[1] 1974-76 data.
[2] Not including main stem depletions.
[3] Not reported separately.
[4] Net exports are not included.

Source: (*23*).

were to operate at full capacity during periods of extreme low flow. Such possibilities, although remote, could doubtless affect the locations of future coal-processing facilities.

The Gulf Region. The more serious water resource problems in the Gulf Region have little to do with coal mining because it is such a small part of the regional economy. In AR-2 and AL-2, no coal is currently produced and none is expected to be produced in the future. The coal now being mined in Texas, as well as that planned for future mines, is to be used in mine-mouth electric power plants, which use large amounts of cooling water. Several proposed new generating plants are expected to use coal from Wyoming and Montana. Only 3 of the 34 projected coal-fired plants would be located in a water-deficit area (the Lower Canadian subregion), but they would obtain their coal from another region (*16*).

While supplies of water in the Gulf Region seem ample for future development, local conditions may limit supplies. Thus, site-specific data must be used in planning water needs for any given plant or even for a particular CPA.

The Pacific Region. Plans for expanding coal production in the Pacific Region are limited, so the problems relating to water tend to be minimal. Alaska has large water resources, and available supplies far exceed foreseeable demands (*124*). Because of the severe climate, however, many rivers flow little or not at all in winter; hence, storage of the full winter supply is sometimes needed. The areas involved in coal development represent fairly small portions of the State, and the water requirements for energy development are only a small part of the water resources (*16*).

In Washington west of the Cascades, available water resources could easily meet the needs for evaporative cooling of thermogenerators in the foreseeable future. Coal production would increase water consumption negligibly (*124*). General conclusions as to the nature and severity of water problems may not be valid for any specific coal development site, because conditions vary from one site to another.

Groundwater

In areas where surface water supplies are scarce, in quantity or availability, groundwater may be a possible alternate source. However, it is difficult to generalize as to where it may be found in quantities sufficient to encourage coal development because aquifers are out of sight and only by drilling a number of wells can their extent and probable yield be established. Thus dependable data on groundwater vary tremendously from one area to another, largely because the extent of drilling varies. The reliability of an aquifer as a source of water depends on its depth, thickness, rate of recharge, and quality. Some aquifers are being pumped at rates which appear in excess of the rate of recharge; this practice is known as "water mining."

The Tongue-Powder River Basin in Wyoming, where surface waters are unusually scarce, is an area where coal developers have considered groundwater as a possible source. Interest has focused on a geological formation called the Madison Group which underlies many of the CPA's in the Northern Great Plains. This formation is a potential source of extensive supplies of groundwater, but the aquifer is deep. It ranges from 4,000 to 5,000 feet deep in parts of eastern Montana to more than 10,000 feet along the eastern slopes of the Big Horn Mountains (*56*). The Madison Group is probably the only likely source of groundwater for coal development in the Northern Great Plains, although its great depth may limit potential usefulness.

It is generally believed that additional development of groundwater will result in water mining in the Rocky Mountain Region. Estimates of availability are not plentiful, but one source indicates that the upper bounds of recoverable ground water are as follows (*23*):

Basin	maf
Upper Colorado	82,940
Lower Colorado	473,000
Sevier Lake Subregion	21,700
Total	577,640

These figures suggest that a huge amount of water is available, but the quantities shown are spread over a four-State area; they represent an inventory of the total stock, not the amount that could be recovered or used in any given time period. The geographical dispersion of groundwater stocks makes site-specific investigations mandatory for any proposed new coal development facility.

In the Interior, Eastern, and Gulf Regions, some groundwater is available nearly everywhere, as all three lie in "water rich" areas, where surface water is also plentiful. Some localities, however, may be deficient in water, so planners must consider its availability when choosing a plant site.

Water Quality

In most areas where coal development is likely, water-quality issues are not whether the available supplies are of the right quality for coal development but whether development will adversely affect water quality for other uses. Water quality can be affected by pollution from two principal sources. The

first is pollution from the mining operation, primarily acid-mine drainage. In the Eastern and Interior Regions, sulfur compounds exposed by the mining process may react with surface or ground water to form acids, which then drain from the mine and pollute the streams below. Acid drainage may occur either in underground mines or in strip mines. It may originate in the mine itself, or as a leachate from the spoil banks of surface mines or the "gob" piles from underground mines. Acid mine drainage problems can occur anywhere, although current laws require that mining companies take appropriate measures to insure against damage to water supplies from any phase of the mining activity (*77*).

The second source of pollution is from coal processing plants, mainly thermogenerators. Cooling water passed through such plants usually absorbs large quantities of heat. If the heated water is discharged directly into a stream, it constitutes thermal pollution, which in turn may cause drastic changes in the aquatic life downstream from the point of discharge. Laws controlling such pollution are strict, so plans for energy conversion plants must take into account the technology required to avoid pollution (thermal or otherwise) of the natural waters below the plants. Again, the measures required are specific to the site, so that we can offer only a generalized statement of the problem here.

Human Resources

Most areas of expanding coal mining are far from large cities, have a low population base and a relatively small work force. Thus, the socioeconomic impact of new coal development on these areas will probably be much stronger than in areas where mining is already well established.

Population Trends

Although the U.S. population generally has been increasing since colonial times, the rate of growth has been far from uniform geographically, a fact of particular interest for this study. The U.S. population increased 18.2 percent between 1950 and 1960, 13.3 percent between 1960 and 1970, and 4.8 percent between 1970 and 1975 (table 29). In 1950-60 and 1960-70, the increase was much larger in metropolitan (metro) locations than in nonmetropolitan (nonmetro) areas.[47] The trend in nonmetro population was characterized by a substantial outmigration in the fifties and a moderate outmigration in the sixties. In the 1970-75 period, the trend was reversed, resulting in a net inmigration. During this 5-year period, the nonmetro population grew at a faster rate than the metro population.

[47] As used here, the term "metro" refers to counties which are a part of a Standard Metropolitan Statistical Area (SMSA), as reported by the U.S. Census in 1975 (*86*).

There are substantial differences in growth patterns among regions. The Rocky Mountain Region has the largest, most persistent growth rate; the population almost tripled in the 35 years from 1940 to 1975. Natural increase and inmigration contributed about equally to the growth. The Pacific Region also grew faster than the U.S. average in the fifties and sixties, but not as much in the 5-year period ending in 1975. Each of the remaining regions experienced a net outmigration in the decades of the fifties and sixties. Natural increase offset the outmigration, resulting in a moderate gain.

Regional averages and totals tend to conceal some important intraregional variations, particularly in the Rocky Mountain Region where the population gain in one CPA, CO-7, was greater than in all the others combined. The population in CO-7 grew from 343,000 to 1,297,000 in the 25 years from 1950 to 1975, an increase of 278 percent (app. table 10). The aggregate growth rate for all the other CPA's in the region was only 51 percent for the same period. CO-7 includes the three counties surrounding the city and county of Denver (but not Denver itself) and has two-thirds of the people living in the region. Most of the growth in CO-7 is due to the rapid expansion of the Denver metropolitan area, plus substantial growth in Colorado Springs, Greeley, Fort Collins, and other cities in the Front Range area just east of the main mountain ranges of Colorado. Some other CPA's in the region, AZ-1 and NM-2 for example, had large percentage growth rates in both the 1960-70 and 1970-75 periods, but the base from which they started was small.

In the Interior Region, AR-1, located mostly in the Ozark Mountains area, had the fastest growth rate in the 1960-75 period. In the Eastern Region, several CPA's decreased in population in both decades, 1950-60 and 1960-70. The largest percentage declines were in KY-4, KY-5, WV-4, and WV-6. In 1970-75, each of these CPA's increased moderately in population, as did most others in the region. In the Gulf Region, the largest population growth occurred in TX-1, especially in Bexar County where San Antonio is located. The dominant growth area in the Pacific Region was in the Seattle metro area. In the 15 years from 1960 to 1975, 24 CPA's declined in population; most of these were in the nonmetro areas of the Northern Great Plains and Eastern Regions.

The CPA's are predominantly nonmetro; in the aggregate they consist of 516 counties, of which 425 (or about 80 percent) are nonmetro (table 30). There are no metro counties in the Northern Great Plains. The Rocky Mountain Region has six metro counties, all of them in CO-7, a CPA dominated by the Denver metro area. The Interior Region has 159 nonmetro counties out of 200, although 52 percent of the people live in metro counties. Eight of the 24 Interior CPA's have no metro counties, and there are but two large metro areas (over 0.5 million population) in the CPA's of the re-

gion—Kansas City and Tulsa. One of the counties in IL-2 is part of the Chicago metro area, and two counties in IL-3 are part of the St. Louis metro area, but the central metro city of each is outside the boundaries of the CPA.

In the Eastern Region, 10 CPA's have no metro counties and 12 CPA's have some metro and some nonmetro counties. About 80 percent of the counties in the region are nonmetro. The principal metro areas in the region are Pittsburgh, PA, Birmingham, AL, and Canton, OH. WV-1 is unique as it is the only CPA nationwide that consists entirely of metro counties, the principal metro city being Wheeling, WV. The principal metro centers in the Gulf Region are San Antonio, as noted above, and Little Rock, AR. Seattle and Tacoma are the main metro centers in the Pacific Region.

Most of the Nation's coal is produced in nonmetro areas. All the coal mined in the three western regions—Northern Great Plains, Rocky Mountain, and Pacific—comes from CPA's with no metro counties. A substantial part of the coal in the Interior and Eastern Regions is mined in CPA's which are entirely nonmetro CPA's (table 31). A major portion of the remaining coal, 189 million tons, is produced in CPA's where between 34 and 66 percent of the population is metro. There are 16 counties with more than 10 million tons of coal production, and all but 2 of these are nonmetro (table 32). Belmont County, OH, eighth in coal production, is classified as metro because it is part of the Wheeling, WV, SMSA. Washington County, PA, tenth in coal production, is part of the Pittsburgh SMSA. None of the six leading coal counties is adjacent to any metropolitan center. Large-scale coal pro-

Table 29—Population trends in Coal Production Regions, 1940-75

Area	Population					Change, 1950-60		
	1940	1950	1960	1970	1975	Total	Natural	Net migration
	Thousands					*Percent*		
U.S. total	132,166	151,699	179,323	203,213	213,054	18.2	16.7	1.5
Metro	80,386	100,081	126,455	147,996	154,138	26.4	17.4	8.9
Nonmetro	51,780	51,618	52,868	55,217	58,916	2.4	15.4	−13.0
Regions:[1]								
Northern Great Plains	407	413	430	424	453	4.3	20.3	−15.9
Rocky Mountain	665	770	1,163	1,576	1,940	51.1	26.9	24.2
Interior	6,333	6,475	6,876	7,355	7,594	6.2	12.1	− 5.9
Eastern	9,699	10,182	10,294	10,164	10,419	1.1	14.7	−13.6
Gulf	1,732	1,837	2,001	2,254	2,445	8.9	18.8	− 9.8
Pacific	na	1,218	1,508	1,878	1,909	23.8	16.0	7.8

	Change, 1960-70			Change, 1970-75		
	Total	Natural	Net migration	Total	Natural	Net migration
	Percent					
U.S. total	13.3	11.6	1.7	4.8	3.6	1.2
Metro	17.0	12.3	4.7	4.2	3.8	.4
Nonmetro	4.4	10.1	− 5.6	6.7	3.3	3.4
Regions:[1]						
Northern Great Plains	−1.6	12.9	−14.5	6.9	4.6	2.3
Rocky Mountain	35.5	19.2	16.3	23.1	7.2	15.9
Interior	7.0	7.7	− .7	3.2	2.5	.7
Eastern	−1.3	8.1	− 9.4	2.5	2.6	.1
Gulf	12.6	12.8	− .2	8.5	4.9	3.6
Pacific	24.5	12.1	12.4	1.6	3.4	−1.8

na = Not available.
[1] Data represent the sums of the Coal Production Areas (CPA's) within each region (see app. table 2).

Sources: (*86* and *87*).

Table 30–Distribution of population, metro and nonmetro, 1975[1]

Coal Production Region	Counties[2]			Population[3]			
	Metro	Nonmetro	Total	Metro	Nonmetro	Total	Percentage metro
	Number			*Thousands*			*Percent*
Northern Great Plains	0	47	47	0	453	453	0
Rocky Mountain	6	35	41	1,292	648	1,940	67
Interior	41	159	200	3,925	3,669	7,594	52
Eastern	35	136	171	5,788	4,631	10,419	56
Gulf	7	44	51	1,537	909	2,445	63
Pacific	2	4	6	1,563	346	1,909	82
Total/Average	91	425	516	14,105	10,655	24,760	57

[1] Metro counties are those which constitute any part of a Standard Metropolitan Statistical Area (SMSA).
[2] Excludes Alaska.
[3] Includes Alaska.

Source: (*87*).

Table 31–Coal production in metro and nometro Coal Production Areas (CPA's), 1977

Region	Percentage of population that is metro[1]			All metro CPA's	Nonmetro	Total	Percentage of total
	67-100	34-66	1-33				
	Million tons						*Percent*
Northern Great Plains	0	0	0	0	83.5	83.5	12.1
Rocky Mountain	.1	0	0	.1	43.5	43.6	6.3
Interior	30.4	90.2	1.6	122.3	25.1	147.3	21.2
Eastern	84.8	99.2	50.7	234.7	161.3	395.9	57.1
Gulf	16.8	0	0	16.8	0	16.8	2.4
Pacific	*	0	0	*	5.7	5.7	.8
Total	132.1	189.4	52.3	373.9	319.1	693.0	100.0
				Percent			
	19.1	27.3	7.5	54.0	46.0	100.0	N.A.

*Less than 50,000 tons.
N.A. = not applicable.
[1] Percentage of people in the CPA who lived in metro counties in 1975.

Source: (*87*) and appendix table 3.

duction is essentially a nonmetro activity. Coal mining does not depend on a large metropolitan center for its supply of labor or market outlets; neither does it necessarily draw together a large population.[48]

Employment

Total wage and salary employment in the CPR's in 1975 was 8.8 million workers, of whom 40 percent were in the Eastern Region and 31 percent were in the Interior Region (table 33).[49] The Northern Great Plains had the smallest number of employed workers. In the Eastern Region, the manufacturing industry has the most employees–26 percent of the total–with trade second, and services third. Coal mining accounted for only 4.7 percent of the total employees. In the Interior Region, manufacturing was the most important employing industry with 22.7 percent; government was next, and trades was third. Only 1.1 percent of employment was in coal mining. In each of the other four regions, government employed the most people, trades was second, and services third. Coal mining was near the bottom in each region, and for all the CPA's combined it accounted for only 2.36 percent of all employed persons.

In the 5 years, 1970-75, wage and salary employment rose 10 percent in the six regions; the number increased from 8.0 million to 8.8 million (table 34). In percentage terms the largest increase was in the Rocky Mountain Region, nearly 40 percent, and the smallest was in the Eastern Region, only 6 percent. In the same period, coal mining employment increased from about 138,000 workers to 209,000 workers, an average annual growth rate of about 10 percent. Although the Pacific and Northern Great Plains Regions showed the largest percentage increase, the Eastern region grew most in numbers of workers. The fact that coal mining employment in the Eastern Region increased 48 percent while coal production decreased 5.1 percent during the same period suggests a substantial decrease in production per coal mining employee.

Selected Socioeconomic Characteristics

Since most CPA's are nonmetro, it follows that they should generally have the socioeconomic characteristics of other nonmetro areas. Pertinent statistics bear this out. Family income and individual earnings in five of the six CPR's are substantially below the average for all metro areas in the United States, but above or near the level of the nonmetro average (table 35). The exception is the Pacific Region, which includes Alaska where wages and prices have been relatively high since statehood. A low rate of poverty is another indicator of economic well being. Five of the CPR's have more poverty than the U.S. metro areas, but less than the average of nonmetro areas. The exception is the Pacific Region. The CPR's generally have lower labor force participation rates than do metro areas. As indicated by median age, the people of the Interior and Eastern Regions are older than those in the rest of the United States. The people of Eastern and Gulf Regions have less schooling (that is, lower median school years and a lower high school completion rate) than the rest of the U.S. population. Fertility rates and dependency rates are generally higher than the national average. The mobility rate in the Eastern Region is much lower than the national average, whereas in the Pacific Region it is much higher.[50]

Although most of the area of the CPA's is nonmetro, somewhat more than half the people live in metro counties. Migration patterns, as well as other socioeconomic characteristics, are roughly similar to those observed in nonmetro areas. While coal mining is a major occupation in some local areas,

[48] For a detailed analysis of the general characteristics of metro and nonmetro areas, see (*30*).

[49] Wage and salary employment data were used in place of Census data because the latter are not available by county for any year since 1970.

[50] For a detailed analysis of the socioeconomic characteristics of the people of the Northern Great Plains, see (*50*).

Table 32–Leading coal-producing counties, 1977

Rank	County	Coal Production Area	Production
			Million tons
1	Pike	KY-4	18.1
2	Campbell	WY-2	17.4
3	Muhlenburg	KY-1	17.2
4	Buchanan	VA-1	16.5
5	Big Horn	MT-4	14.8
6	Carbon	WY-3	12.1
7	Rosebud	MT-4	12.1
8	Belmont	OH-1	11.8
9	Wise	VA-1	11.3
10	Washington	PA-1	11.2
11	Navajo	AZ-1	11.1
12	Indiana	PA-2	10.4
13	Monongalia	WV-2	10.4
14	Hopkins	KY-1	10.4
15	Ohio	KY-1	10.3
16	Warrick	IN-3	10.1

Note: *Underlining* indicates metro counties; Belmont county is part of the Wheeling, WV, Standard Metropolitan Statistical Area (SMSA), and Washington county is part of the Pittsburgh, PA, SMSA.

Source: (*103*).

it is a relatively small part of the total employment pattern from a regional and national perspective. In a few CPA's, coal mining is a relatively new and rapidly expanding activity; most such areas have a low population base and a relatively small work force. The socioeconomic impact of coal development on such areas is expected to be much more severe than in CPA's where mining activity is already well established and where the expansion rate is expected to be more gradual (*48*).

Table 33—Employment by industry groups, by Coal Production Region, 1975

Industry	Northern Great Plains	Rocky Mountain	Interior	Eastern	Gulf	Pacific	Total or average
				Percent			
Coal mining	1.43	0.93	1.13	4.72	0.05	0.08	2.36
Other mining	5.52	1.76	.89	.41	1.02	.22	.80
Government	26.55	29.77	21.14	16.59	28.38	24.84	21.12
Manufacturing	4.59	12.16	22.72	26.38	16.10	16.95	21.86
Contract construction	8.98	6.49	4.45	4.30	5.10	4.91	4.74
Transportation	6.94	3.98	5.78	6.12	4.73	6.23	5.74
Trades	20.85	21.22	20.72	19.33	19.69	21.12	20.13
Finance, insurance, and real estate	2.80	3.82	4.29	3.90	4.73	6.00	4.27
Services	16.90	17.87	16.71	17.29	18.71	18.36	17.39
Agriculture, forestry, and fisheries	5.43	2.01	2.16	.96	1.50	1.29	1.58
Total	100	100	100	100	100	100	100
				Thousands			
Total employment	174	647	2,716	3,578	901	828	8,844

Totals may not add to 100 because of rounding.

Source: (*88*).

Table 34—Changes in employment in coal mining and in all industries, 1970 and 1975

Region	Employment in all industries			Coal mining employment		
	1970	1975	Increase	1970	1975	Increase
	Number		*Percent*	*Number*		*Percent*
Northern Great Plains	136,448	173,997	27.5	772	2,483	221.6
Rocky Mountain	462,806	646,508	39.7	3,283	6,012	83.1
Interior	2,484,507	2,716,245	9.3	20,196	30,668	51.9
Eastern	3,365,073	3,577,875	6.3	113,781	168,898	48.4
Gulf	823,902	901,178	9.4	0	440	–
Pacific	759,905	827,844	8.9	159	625	293.1
Total or average	8,032,641	8,843,647	10.1	138,191	209,126	51.3

– = Not applicable.

Source: (*88*).

Table 35—Selected socioeconomic characteristics, 1969 and 1970

Area	1969				1970								
	Median family income	Median earnings		Poverty incidence[1]	Labor force participation rate[1]		Median age	Median school years	Fertility rate[1]	High school completion rate[1]	Dependency rate[1]	Mobility rate[1]	Husband and wife families[1]
		Male	Female		Male	Female							
	Dollars			*Percent*			*Number*			*Percent*			
United States	9,590	7,515	3,413	13.7	72.9	39.6	28.1	12.1	2,956	52.3	79.5	40.4	86.0
Metropolitan	10,406	8,008	3,660	11.3	74.4	40.8	28.0	12.2	2,859	55.1	77.1	40.8	85.5
Nonmetropolitan	7,615	6,128	2,742	20.2	68.8	36.1	28.3	11.2	3,245	45.0	86.5	39.1	87.2
Northern Great Plains	8,068	6,353	2,234	15.6	72.8	34.7	26.5	12.1	3,639	51.8	92.3	40.5	89.9
Rocky Mountain	9,601	7,603	3,018	14.7	74.5	38.8	24.3	12.4	3,182	64.3	82.4	40.4	89.2
Interior	[2]8,527	[2]6,974	[2]3,008	13.8	71.2	37.6	29.6	12.0	3,053	51.5	83.3	43.6	88.3
Eastern	[2]8,172	[2]7,088	[2]3,034	17.5	67.3	31.5	29.8	11.4	2,957	45.8	80.3	33.8	86.0
Gulf	7,317	5,798	2,808	23.7	69.2	36.4	26.9	11.1	3,179	43.9	83.7	42.9	84.8
Pacific	11,154	8,769	3,953	8.8	76.4	40.8	27.0	12.4	2,960	66.3	72.6	48.4	88.8

[1] For method of calculation, see (*50*).
[2] Mean of the area medians.

Source: (*86*).

Implications

In this report, we have described the resources of coal, agriculture, water, and people, and we have described the relationship between these resources and coal development. However, the quality of some of the estimated data can be improved. Better data should then lead to improved results from the national analytical model.

First, available estimates of land required for permanent mine facilities vary significantly from one area to another and from one source reference to another, partly because of differences among definitions of "fixed" land requirements. We need a detailed survey of existing mines and of planned new mines to ascertain the acreage actually used for shops, offices, parking lots, coal-handling and cleaning facilities, onsite coal storage, haul roads, railroad loops, or sidings, and similar fixed facilities.

Second, in calculating the value of agricultural production at risk from coal development, we used data from the 1974 Census of Agriculture, the most recent available. However, results from the 1978 Census of Agriculture will soon be published; our estimates could then be updated.

Third, we established the CPA's based on the latest available nationwide compilations of coal reserves. More recent data on coal reserves are just now becoming available for specific areas. More complete data on coal resources and reserves would yield more accurate estimates of reserve totals.

Last, additional problems need study–including studies of the effect of coal-produced pollutants, such as "acid rain," on agricultural production; site-specific studies of land requirements and changes in patterns of ownership and farm operation in areas where new mines are contemplated; and more detailed studies of the impact of coal development on water supplies, both surface and underground. Such studies could help to solve problems faced by those in industry and government who must plan for coal development.

Bibliography

(1) Alaska State Division of Forest, Land, and Water Management. *Land for Alaskans.* December 1978.

(2) Anderson, Donald. *Feasibility Study of Mining Alaska Coal and Transportation by Slurry to the West Coast.* Prepared by the Department of Mining, Metallurgical, and Ceramic Engineering, University of Washington, for the U.S. Bureau of Mines, 1977.

(3) Averitt, Paul. *Coal Resources of the United States, January 1, 1974.* Bulletin 1412. U.S. Department of the Interior, Geological Survey, 1975.

(4) _____. *Stripping–Coal Resources of the United States–January 1, 1970.* Bulletin 1332. U.S. Department of the Interior, Geological Survey, 1970.

(5) Barnes, Farrell F. *Coal Resources of Alaska.* Bulletin 1242-B. U.S. Department of the Interior, Geological Survey, 1967.

(6) Beilkman, H. M., and H. D. Gower. "Coal," *Mineral and Water Resources of Washington.* 89th Congress, 2nd Session, Committee on Interior and Insular Affairs, Committee Print, 1967, pp. 276-286.

(7) Benson, David C., and Frank J. Doyle. *Projects to Expand Fuel Sources in Eastern United States* (as of July 1977). Information Circular 8765. U.S. Department of Interior, Bureau of Mines, 1978.

(8) Berkshire, L. H., and E. L. Hemingway. *Basic Estimated Capital Investment and Operating Costs for Three Coal Strip Mines.* RE/EES-78/1. U.S. Department of Energy, Engineering Economics and Standards Section, November 1977.

(9) Brown, Donald M. *Lignite Resources of South Dakota.* Geological Survey Circular 81. U.S. Department of the Interior, 1952.

(10) Carter, Ralph P., and Roy E. Cameron. *Land Reclamation Program–Annual Report, July 1975-July 1976.* Argonne National Laboratory, December 1976.

(11) Cavallaro, J. A., M. T. Johnston, and A. W. Deurbrouck. *Sulfur Reduction Potential of U.S. Coals: A Revised Report of Investigations.* Joint EPA-Bureau of Mines Report, EPA 600/2-76-091, Bureau of Mines RI 8118, April 1976.

(12) Charles River Associates, Inc. *The Economic Impact of Public Policy on the Appalachian Coal Industry and the Regional Economy.* Vol. I and II. January 1973.

(13) Corsentino, John S. *Projects to Expand Fuel Sources in Western States (as of May 1976).* Information Circular 8719. U.S. Department of the Interior, Bureau of Mines, 1976.

(14) Culbertson, William C. *Geology and Coal Resources of the Coal Bearing Rocks of Alabama.* Bulletin 1182-B. U.S. Department of the Interior, Geological Survey, 1964.

(15) Dick, James. *Staff Report on Mineral Leasing on Indian Lands.* Federal Trade Commission, Bureau of Competition, Washington, D.C., October 1975.

(16) Dobson, Jerome E., and others. *A Nationwide Assessment of Water Quantity Impacts on the National Energy Plan,* Vol. I: *Summary and Conclusions.* Sponsored by U.S. Department of Energy, Oak Ridge National Laboratory, Oak Ridge, Tenn., December 1977.

(17) Doyle, John C., Jr. *State Strip Mining Laws: An Inventory and Analysis of Key Statutory Provisions in 28 Coal Producing States.* Environmental Policy Institute, Washington, D.C., March 1977.

(18) Dupree, W. G., and J. S. Corsentino. *United States Energy through the Year 2000* (revised). U.S. Department of the Interior, Bureau of Mines, December 1975.

(19) Energy and Environmental Analysis, Inc. *Benefit-Cost Analysis of Laws and Regulations Affecting Coal: Case Studies on Reclamation, Air Pollution, and Health and Safety Laws and Regulations.* Prepared for Office of Mineral Policy and Research Analysis, U.S. Department of the Interior, July 1977.

(20) Environmental Research and Technology, Inc. *An Overview of Federal Coal Mine Regulations: Requirements of the Federal Surface Mining and Control Reclamation Act of 1977.* September 1979.

(21) Evans, R. J., and J. R. Bitler. *Coal Surface Mining Reclamation Costs–Appalachian and Midwestern Coal Supply Districts.* Information Circular 8695. U.S. Department of the Interior, Bureau of Mines, 1976.

(22) Grandt, Alten F. "Mined Land Reclamation in the Interior Coal Province," *Journal of Soil and Water Conservation*, Vol. 22, No. 2, March-April 1978, pp. 62-68.

(23) Gray, S. Lee, Edward W. Sparling, and Norman K. Whittlesey. *Water for Energy Development.* NRED 80-3. U.S. Department of Agriculture, ESCS Staff Report, December 1979.

(24) Green, John W. *Western Energy: The Interregional Coal Analysis Model.* TB-1627. U.S. Department of Agriculture, Economics, Statistics, and Cooperatives Service, August 1980.

(25) Grim, E. C., and R. D. Hill. *Environmental Protection in Surface Mining of Coal.* Environmental Protection Agency, Report 670/2-74-093, October 1974.

(26) Hamilton, P. A., D. H. White, Jr., and J. K. Matson. *The Reserve Base of U.S. Coals by Sulfur Content,* Part 2: *The Western States.* Information Circular 8693. U.S. Department of the Interior, Bureau of Mines, 1975.

(27) Harris, Marshall. *Origin of the Land Tenure System in the United States.* Iowa State University Press, Ames, Iowa, 1953.

(28) Hennagin, David B. "Appendix: Cook Inlet Coal: Economics of Mining and Marine Slurry Transport." Prepared by the University of Washington, Department of Mining, Metallurgical, and Ceramic Engineering for the U.S. Bureau of Mines, January 1978.

(29) Hill, Ronald D. "Control and Prevention of Mine Drainage." Paper presented at Battelle Conference, Columbus, Ohio, November 1972.

(30) Hines, Fred K., David L. Brown, and John M. Zimmer. *Social and Economic Characteristics of the Population in Metro and Nonmetro Counties, 1970.* AER-272. U.S. Department of Agriculture, Economic Research Service, March 1975.

(31) Hoffman-Munter Corporation. Correspondence with Elmer C. Holt, Jr., Vice-President. Silver Spring, Md., August 17, 1979.

(32) Holmberg, George V. "Vegetation Establishment on Abandoned Coal Mined Land." Paper presented at the 1978 Winter Meeting, American Society of Agricultural Engineers, Chicago, Ill., December 18-20, 1978.

(33) ICF, Inc. *Energy and Economic Impacts of H.R. 13950* (Surface Mining Control and Reclamation Act of 1976). Final Report (Appendices). Report submitted to the Council on Environmental Quality and Environmental Protection Agency, September 1977.

(34) Illinois Department of Mines and Minerals. *1976 Annual Report.* Springfield, Ill., 1976.

(35) Illinois South Project, Inc. *A Handbook on Coal Leasing and Land Owners Organization.* Carterville, Ill., Winter 1976.

(36) Imhoff, E. A., Thomas L. Fritz, and J. R. LaFevers. *A Guide to State Programs for the Reclamation of Surface Mine Areas.* Circular 732. U.S. Department of the Interior, Geological Survey, 1976.

(37) Johnson, Wilton, and George C. Miller. *Abandoned Coal-Mined Lands: Nature, Extent, and Cost of Reclamation.* U.S. Department of the Interior, Bureau of Mines, 1979.

(38) Kaiser Engineers, Inc. *Technical and Economic Feasibility Surface Mining Coal Deposits North Slope of Alaska.* Prepared for the U.S. Bureau of Mines, August 1977.

(39) Katell, Sidney, E. L. Hemingway, and L. H. Berkshire. *Basic Estimated Capital Investment and Operating Costs of Coal Strip Mines.* Information Circular 8703 (revision of Information Circular 8661). U.S. Department of the Interior, Bureau of Mines, 1976.

(40) Lawrence, Anthony G. *The Causes and Consequences of the Changing Pattern of Coal Mine Ownership: An A Priori Analysis.* University of Kentucky, Lexington, Ky., September 1975.

(41) Leathers, K. L. *Costs of Strip Mine Reclamation in the West.* RDRR-19. U.S. Department of Agriculture, Economics, Statistics, and Cooperatives Service, February 1980.

(42) Leistritz, F. Larry, and Stanley W. Voelker. "Coal Resource Ownership: Patterns, Problems, and Suggested Solutions," *Natural Resources Journal,* Vol. 15, October 1975, pp. 643-662.

(43) McGraw-Hill, Inc. *Coal Week.* Various issues.

(44) McGraw-Hill Publications. *Keystone Coal Industry Manual.* Various years (annual).

(45) Miller, Tom D. "Who Owns West Virginia?" Reprinted from the *Herald Dispatch,* Huntington, W.Va., December 1974.

(46) Missouri Basin Interagency Committee. *Missouri River Basin Comprehensive Framework Study.* June 1969.

(47) Missouri River Basin Commission. *Yellowstone River Basin and Adjacent Coal Areas Level B. Study.* Omaha, Nebr., November 1978.

(48) Murdock, Steve H., and F. Larry Leistritz. *Energy Development in the Western United States.* New York: Praeger Publishers, 1979.

(49) Mutschler, P. H., R. J. Evans, and G. M. Larwood. *Comparative Transportation Costs of Supplying Low Sulfur Fuels to Midwestern and Eastern Energy Markets.* Information Circular 8614. U.S. Department of the Interior, Bureau of Mines, 1973.

(50) Myers, Paul R., Fred K. Hines, and Jeff. V. Conopask. *A Socioeconomic Profile of the Northern Great Plains Coal Region.* AER-400. U.S. Department of Agriculture, Economics, Statistics, and Cooperatives Service, March 1978.

(51) National Academy of Engineering. *U.S. Energy Prospects: An Engineering Viewpoint.* Report prepared by the Academy's Task Force on Energy, 1974.

(52) National Academy of Sciences. *Rehabilitation Potential of Western Coal Lands.* Report to the Energy Policy Project of the Ford Foundation. Cambridge, Mass.: Ballinger Publishing Co., 1974.

(53) National Coal Association. *Steam Electric Plant Factors.* 1976.

(54) Nehring, Richard, Benjamin Zycher, and Joseph Wharton. *Coal Development and Government Regulation in the Northern Great Plains.* Report R-1981-NSF/RC. Santa Monica, Calif.: The Rand Corporation, August 1976.

(55) Northern Great Plains Resource Program. *Effects of Coal Development in the Northern Great Plains.* Summary Report. Denver and Washington, D.C., April 1975.

(56) _____. *Water Work Group Report.* December 1974.

(57) Noyes Data Corporation. *Coal Resources, Characteristics, and Ownership in the U.S.* Park Ridge, N.J., 1978.

(58) Ostendorf, David L., and Joan E. Gibson. *Illinois Land–The Emerging Conflict Over the Use of Land, Agricultural Production and Coal Development.* The Illinois South Project, Inc., Carterville, Ill., Summer 1976.

(59) Pacific Southwest Interagency Committee. *Lower Colorado Region Comprehensive Framework Study.* Appendix V: Water Resources. Water Resources Council, June 1971.

(60) Packer, P. E. *Rehabilitation Potentials and Limitations of Surface-Mined Land in the Northern Great Plains.* General Technical Report INT-14. U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station, Ogden, Utah, 1974.

(61) Page, Walter P. "Competition and Concentration in Appalachian Coal Production, 1960 to 1975," *Policy Analysis and Information Systems,* Vol. 1, June 1979, pp. 141-160.

(62) Paone, J., J. L. Morning, and L. Georgetti. *Land Utilization and Reclamation in the Mining Industry, 1930-1971.* Information Circular 8642. U.S. Department of the Interior, Bureau of Mines, 1974.

(63) Persse, Franklin H., David W. Lockard, and Alec A. Lindquist. *Coal Surface Mining Reclamation Costs in the Western States.* Information Circular 8737. U.S. Department of the Interior, Bureau of Mines, 1977.

(64) Plass, William T. "Reclamation of Coal-Mined Land in Appalachia," *Journal of Soil and Water Conservation,* Vol. 33, No. 2, March-April 1978, pp. 56-61.

(65) Price, Don, and Ted Arrow. *Summary Appraisals of the Nation's Ground Water Resources–Upper Colorado Region.* Professional Paper 813-C. U.S. Geological Survey, 1974.

(66) Radian Corporation. *An Environmental Overview of Future Texas Lignite Development.* DCN No. 77-200-187-06-06. U.S. Environmental Protection Agency, January 1978.

(67) Rick, Charles H., Jr. *Projects to Expand Energy Sources in the Western States* (as of August 1977). Information Circular 8772. U.S. Department of the Interior, Bureau of Mines, 1978.

(68) Rieber, Michael. "Low Sulfur Coal: A Revision of Reserve and Supply Estimates," *Journal of Environmental Economics and Management*, Vol. 2, 1975, pp. 40-59.

(69) Schaub, John R., Joseph R. Barse, and Lloyd D. Bender. "Research Program on the Economic and Social Consequences of Coal and Oil Shale Development," *Health, Environmental Effects, and Control Technology of Energy Use.* Environmental Protection Agency, Report 600/7-76-002. Proceedings of February 1976 conference.

(70) Selvig, W. A., and others. *American Lignites: Geological Occurrence, Petrographic Composition, and Extractable Waxes.* Bulletin 482. U.S. Department of the Interior, Bureau of Mines, 1950.

(71) Smith, Albert E., Thomas D. Walsko, and Richard R. Cirello. *Coal Supply and Air Quality Limitations on Fossil-Fueled Energy Centers.* Argonne National Laboratory, August 1976.

(72) Smith, J. B. *Strippable Coal Reserves of Wyoming: Location, Tonnage, and Characteristics of Coal and Overburden.* Information Circular 8538. U.S. Department of the Interior, Bureau of Mines, 1972.

(73) Strovel, Raymond B., and others. *Mineral Resources and Industries of Arkansas.* Bulletin 645. U.S. Department of the Interior, Bureau of Mines, 1969.

(74) Thomson, R. D., and H. F. York. *The Reserve Base of U.S. Coals by Sulfur Content.* Part 1: *The Eastern States.* Information Circular 8680. U.S. Department of the Interior, Bureau of Mines, 1975.

(75) Toenges, Albert L. *Reclamation of Stripped Coal Land.* Report of Investigations Number 3440. U.S. Bureau of Mines, Washington, D.C., February 1939.

(76) U.S. Congress. "Federal Coal Leasing Amendments Act." Public Law 94-377, August 4, 1976.

(77) _____. "Surface Mining Control and Reclamation Act of 1977." Public Law 95-87, 95th Congress, 91 Stat. 445, August 3, 1977.

(78) _____, House of Representatives, Committee on Interior and Insular Affairs. *Committee Report on the Federal Coal Leasing Amendments Act of 1975.* November 21, 1975.

(79) U.S. Department of Agriculture, Economics, Statistics, and Cooperatives Service. "Resources of the _____ Region and Coal Development." ESCS working papers, one for each region as follows:
Northern Great Plains–April 1977
Rocky Mountain–April 1978
Interior–August 1978
Eastern–December 1978
Gulf–June 1979
Pacific–May 1979

(80) _____, Forest Service. *Areas of National Forest and Other Lands Administered by the Forest Service as of June 30, 1974.* Washington, D.C.

(81) _____ *Land Areas of the National Forest System as of September 30, 1978.* File 1380 (5400). Washington, D.C., November 1978.

(82) _____, Soil Conservation Service. *The Status of Land Disturbed by Surface Mining in the United States: Basic Statistics by State and County, as of July 1, 1977.* SCS-TP-158. 1979.

(83) _____. *Plant Performance on Surface Coal Mine Spoil in the Eastern United States.* SCS-TP-155. April 1978.

(84) U.S. Department of Commerce, Bureau of the Census. *Census of Agriculture.* Vol. 1, 1974.

(85) _____. "General Housing Characteristics," *Census of Housing, 1970.*

(86) _____. *Census of Population.* 1940, 1950, 1960, and 1970.

(87) _____. *Current Population Reports.* Series P-25, various issues, and Series P-26.

(88) _____, Bureau of Economic Analysis. *Regional Economic Information System.* No date.

(89) U.S. Department of Energy. *Status of Coal Supply Contracts for New Electric Generating Units, 1977-1986.* First Annual Supplement. DOE/FERC-0004/1. May 1978.

(90) _____, Energy Information Administration. "Energy Data Reports," *Weekly Coal Reports.* Various issues.

(91) _____, Leasing Policy Development Office. *Federal Coal Leasing and 1985 and 1990 Regional Coal Production Forecasts.* June 1979.

(92) _____, Office of Coal Supply Development. *Western Coal Development Monitoring System.* April 1979.

(93) U.S. Department of the Interior, Bureau of Indian Affairs, Office of Trust Responsibilities. *Annual Report of Indian Lands as of September 30, 1977.* 1977.

(94) _____, Bureau of Land Management. *Annual Reports of BLM State Offices.* Various titles, 1978 and earlier years.

(95) _____. *Everything you always wanted to know about Land Status . . . but were afraid to ask.* Bureau of Land Management State Office, Anchorage, Alaska, 1978.

(96) _____. *Federal Coal Management Program.* Final Environmental Statement, April 1979.

(97) _____. *Known Recoverable Coal Resource Areas–Surface/Subsurface Ownership Patterns.* 1978.

(98) _____. *Public Land Statistics, 1976.* 1976.

(99) _____. *West Central North Dakota Regional Environmental Impact Study on Energy Development.* Draft, in cooperation with State of North Dakota, Bismarck, N. Dak., January 1978.

(100) _____, Bureau of Mines. *Cost Analysis of Model Mines for Strip Mining of Coal in the United States.* Information Circular 8535. 1972.

(101) _____. *Economic Engineering Analysis of U.S. Surface Coal Mines and Effective Reclamation.* Open File Report 74-75. 1975.

(102) _____. *Mineral Industry Surveys, Bituminous Coal and Lignite Distribution.* Various years.

(103) _____. *Mineral Industry Surveys, Coal–Bituminous and Lignite Production.* Various years.

(104) _____. *Mineral Industry Surveys, Effects of Air Quality Requirements on Coal Supplies,* May 1976.

(105) _____. *Mineral Yearbooks.* Various years since 1932.

(106) _____. *Strippable Reserves of Bituminous Coal and Lignite in the U.S.* Information Circular 8531. 1971.

(107) _____, Bureau of Reclamation and the State of Colorado. *Colorado State Water Plan, Phase 1–Appraisal Report.* February 1974.

(108) _____, Bureau of Reclamation. *Projected Water Supply and Depletion, Upper Colorado River Basin.* August 1976.

(109) _____. *Quality of Water, 1975, Colorado River Basin.* Progress Report No. 7, 1975.

(110) _____, Geological Survey. *1970 Water Resource Data for Montana, North Dakota, South Dakota, and Wyoming, Surface Water Records.* 1971.

(111) _____, Office of Surface Mining Reclamation and Enforcement. *Permanent Regulatory Program of the Surface Mining Control and Reclamation Act of 1977.* Final regulatory analysis, OSM-RA-1. Washington, D.C., March 1979.

(112) _____, Water for Energy Management Team. *Report on Water for Energy in the Northern Great Plains.* January 1975.

(113) U.S. Environmental Protection Agency. *Processes, Procedures, and Methods of Control Pollution from Mining Activities.* EPA-430/9-73-011. October 1973.

(114) U.S. Federal Energy Administration. *Trends in Power Plants Capacity: Inventory of Power Plants in the United States.* April 1976.

(115) _____. *National Energy Outlook.* 1976.

(116) U.S. Federal Power Commission, Division of Power Surveys and Analysis. *Status of Coal Supply Contracts for New Electric Generating Units, 1976-1985.* Washington, D.C., 1977.

(117) U.S. Federal Register. "Abandoned Mine Land Reclamation Program Provisions," Vol. 43, No. 81, Part III, April 26, 1978.

(118) _____. "Federal Coal Ownership in Eastern States," BLM Data by Counties, Vol. 44, No. 103, May 25, 1979, pp. 30590-92.

(119) _____. "New Stationary Sources Performance Standards, Electric Utility Steam Generating Units," Vol. 44, No. 113, 40 CFR, Part 60, June 11, 1979.

(120) _____. "Surface Coal Mining and Reclamation Enforcement Provisions–Proposed Rules for Permanent Regulatory Program," Vol. 43, No. 181, Part III, September 18, 1978.

(121) _____. "Surface Mining Reclamation and Enforcement Provisions," Vol. 42, No. 239, Part II, Ch. VII, December 13, 1977.

(122) U.S. General Services Administration, Office of Administration. *Real Property Owned by the United States.* County Data, 1975. Summary Report, 1977.

(123) U.S. Water Resources Council. *Water for Energy Self-Sufficiency.* Washington, D.C., October 1974.

(124) _____. *Water Requirements, Availabilities, Constraints, and Recommended Federal Actions.* Project Independence Blueprint, Prepared for U.S. Federal Energy Administration, Washington, D.C., November 1974.

(125) Watts, M. J. "Estimated Costs of Spoil Bank Reclamation Alternatives." Staff paper 75-24, Department of Economics, Montana State University, Bozeman, Mont., 1975.

(126) J. W. Wilson & Associates, Inc. *Report to Federal Trade Commission on the Structure of the Nation's Coal Industry.* Washington, D.C., April 1978.

(127) Young, Robert A., and George Stepko, Jr. *Ownership and Land Use Constraints Upon the Recoverability of Coals: A Methodology and Test Case.* West Virginia University, Morgantown, W. Va., 1976.

Appendix table 1—Counties included in Coal Production Areas

NORTHERN GREAT PLAINS REGION

MT-1
091 Sheridan

MT-2
021 Dawson
025 Fallon
083 Richland
085 Roosevelt
109 Wibaux

MT-3
055 McCone
079 Prairie

MT-4
003 Big Horn
033 Garfield
065 Musselshell
087 Rosebud
103 Treasure

MT-5
017 Custer
075 Powder River

ND-1
013 Burke
023 Divide
049 McHenry
053 McKenzie
055 McLean
061 Mountrail
101 Ward
105 Williams

ND-2
007 Billings
015 Burleigh
025 Dunn
033 Golden Valley
057 Mercer
059 Morton
065 Oliver

ND-3
001 Adams
011 Bowman
037 Grant
041 Hettinger
087 Slope
089 Stark

SD-1
031 Corson
041 Dewey
063 Harding
105 Perkins

WY-1
033 Sheridan

WY-2
005 Campbell
019 Johnson

WY-3
007 Carbon
009 Converse

WY-4
023 Lincoln
037 Sweetwater

ROCKY MOUNTAIN REGION

AZ-1
001 Apache
005 Coconino
017 Navajo

CO-1
081 Moffat
107 Routt

CO-2
057 Jackson

CO-3
043 Fremont
093 Park

CO-4
029 Delta
045 Garfield
051 Gunnison
077 Mesa
085 Montrose
091 Ouray
097 Pitkin
103 Rio Blanco

CO-5
007 Archuleta
067 LaPlata
083 Montezuma

CO-6
055 Huerfano
071 Las Animas

CO-7
001 Adams
005 Arapahoe
013 Boulder
039 Elbert
041 El Paso
059 Jefferson
123 Weld

NM-1
045 San Juan

NM-2
031 McKinley
043 Sandoval

NM-3
007 Colfax

NM-4
053 Socorro

UT-1
007 Carbon
015 Emery
041 Sevier

UT-2
017 Garfield
025 Kane
055 Wayne

UT-3
047 Uintah

INTERIOR REGION

AR-1
033 Crawford
047 Franklin
071 Johnson
083 Logan
115 Pope
127 Scott
131 Sebastian

IL-1
001 Adams
009 Brown
011 Bureau
057 Fulton
067 Hancock
073 Henry
095 Knox
109 McDonough
131 Mercer
143 Peoria
161 Rock Island
169 Schuyler
175 Stark
187 Warren

IL-2
063 Grundy
091 Kankakee
099 LaSalle
105 Livingston
113 McLean
123 Marshall
155 Putnam
179 Tazwell
197 Will
203 Woodford

IL-3
005 Bond
013 Calhoun
017 Cass
021 Christian
051 Fayette
061 Greene
083 Jersey
107 Logan
115 Macon
117 Macoupin
129 Menard
135 Montgomery
137 Morgan
139 Moultrie
167 Sangamon
171 Scott
173 Shelby

IL-4
023 Clark
029 Coles
035 Cumberland
041 Douglas
045 Edgar
183 Vermilion

Appendix table 1—Counties included in Coal Production Areas

INTERIOR REGION—Cont'd.

IL-5
027 Clinton
077 Jackson
119 Madison
133 Monroe
145 Perry
157 Randolph
163 St. Clair
189 Washington

IL-6
033 Crawford
047 Edwards
055 Franklin
059 Gallatin
065 Hamilton
081 Jefferson
101 Lawrence
121 Marion
165 Saline
185 Wabash
191 Wayne
193 White
199 Williamson

IN-1
045 Fountain
121 Parke
165 Vermillion

IN-2
021 Clay
119 Owen
153 Sullivan
167 Vigo

IN-3
027 Daviess
037 Dubois
051 Gibson
055 Greene
083 Knox
101 Martin
123 Perry
125 Pike
129 Posey
147 Spencer
163 Vanderburg
173 Warrick

IA-1
117 Lucas
123 Mahaska
125 Marion
135 Monroe
179 Wapello

IA-2
007 Appanoose
015 Boone
049 Dallas
051 Davis
053 Decatur
073 Greene
077 Guthrie
079 Hamilton
083 Hardin
087 Henry
099 Jasper
101 Jefferson
107 Keokuk
111 Lee
127 Marshall
153 Polk
163 Scott
169 Story
177 Van Buren
181 Warren
187 Webster

KS-1
005 Atchison
013 Brown
103 Leavenworth
131 Nemaha

KS-2
059 Franklin
139 Osage

KS-3
011 Bourbon
021 Cherokee
035 Cowley
037 Crawford
107 Linn

KY-1
031 Butler
047 Christian
055 Crittenden
059 Daviess
061 Edmonson
085 Grayson
091 Hancock
101 Henderson
107 Hopkins
149 McLean
177 Muhlenburg
183 Ohio
225 Union
233 Webster

MO-1
001 Adair
061 Daviess
079 Grundy
081 Harrison
129 Mercer
147 Nodaway
171 Putnam
197 Schuyler
211 Sullivan
227 Worth

MO-2
025 Caldwell
033 Carroll
047 Clay
107 Lafayette
117 Livingston
177 Ray
195 Saline

MO-3
007 Audrain
019 Boone
027 Callaway
041 Chariton
089 Howard
115 Linn
121 Macon
137 Monroe
139 Montgomery
173 Ralls
175 Randolph

MO-4
037 Cass
083 Henry
101 Johnson
159 Pettis
185 St. Clair

MO-5
011 Barton
013 Bates
039 Cedar
057 Dade
097 Jasper
217 Vernon

OK-1
035 Craig
091 McIntosh
101 Muskogee
105 Nowata
107 Okfuskee
111 Okmulgee
131 Rogers
143 Tulsa
145 Wagoner

OK-2
061 Haskell
079 LeFlore
135 Sequoyah

OK-3
005 Atoka
029 Coal
077 Latimer
121 Pittsburg

EASTERN REGION

AL-1
009 Blount
043 Cullman
049 DeKalb
057 Fayette
071 Jackson
073 Jefferson
093 Marion
115 St. Clair
117 Shelby
125 Tuscaloosa
127 Walker
133 Winston

KY-2
019 Boyd
089 Greenup
127 Lawrence

KY-3
025 Breathitt
043 Carter
051 Clay
063 Elliott
109 Jackson
115 Johnson
121 Knox
125 Laurel
129 Lee
153 Magoffin
165 Menifee
175 Morgan
189 Owsley
197 Powell
199 Pulaski
203 Rockcastle
237 Wolfe

KY-4
071 Floyd
119 Knott
133 Letcher
159 Martin
195 Pike

Appendix table 1—Counties included in Coal Production Areas—Continued

EASTERN REGION—Cont'd.

KY-5
013 Bell
095 Harlan
131 Leslie
193 Perry
235 Whitley

KY-6
053 Clinton
147 McCreary
231 Wayne

MD-1
001 Allegany
023 Garrett

OH-1
013 Belmont
019 Carroll
029 Columbiana
031 Coshocton
059 Guernsey
067 Harrison
075 Holmes
081 Jefferson
099 Mahoning
111 Monroe
119 Muskingum
127 Perry
151 Stark
157 Tuscarawas
169 Wayne

OH-2
115 Morgan
121 Noble
167 Washington

OH-3
009 Athens
073 Hocking

OH-4
053 Gallia
079 Jackson
087 Lawrence
105 Meigs
145 Scioto
163 Vinton

PA-1
033 Allegheny
007 Beaver
019 Butler
059 Greene
073 Lawrence
085 Mercer
121 Venango
125 Washington

PA-2
005 Armstrong
009 Bedford
013 Blair
015 Bradford
021 Cambria
023 Cameron
027 Centre
031 Clarion
033 Clearfield
035 Clinton
047 Elk
051 Fayette
057 Fulton
061 Huntington
063 Indiana
065 Jefferson
081 Lycoming
083 McKean
111 Somerset
117 Tioga
129 Westmoreland

TN-1
001 Anderson
013 Campbell
025 Claiborne
035 Cumberland
049 Fentress
129 Morgan
133 Overton
137 Pickett
145 Roane
151 Scott

TN-2
007 Bledsoe
061 Grundy
065 Hamilton
115 Marion
141 Putnam
143 Rhea
153 Sequatchie
175 Van Buren
185 White

VA-1
027 Buchanan
051 Dickenson
105 Lee
167 Russell
169 Scott
185 Tazewell
195 Wise

WV-1
009 Brooke
029 Hancock
051 Marshall
069 Ohio

WV-2
001 Barbour
017 Doddridge
033 Harrison
041 Lewis
049 Marion
061 Monongalia
077 Preston
083 Randolph
091 Taylor
095 Tyler
097 Upshur
103 Wetzel

WV-3
023 Grant
057 Mineral
093 Tucker

WV-4
007 Braxton
013 Calhoun
021 Gilmer
087 Roane
101 Webster

WV-5
005 Boone
011 Cabell
015 Clay
039 Kanawha
043 Lincoln
045 Logan
053 Mason
059 Mingo
079 Putnam
099 Wayne

WV-6
019 Fayette
025 Greenbrier
047 McDowell
055 Mercer
067 Nicholas
075 Pocahontas
081 Raleigh
089 Summers
109 Wyoming

GULF REGION

AL-2
005 Barbour
023 Choctaw
031 Coffee
041 Crenshaw
045 Dale
091 Marengo
109 Pike
119 Sumter
131 Wilcox

AR-2
039 Dallas
053 Grant
103 Ouachita
119 Pulaski
125 Saline

TX-1
001 Anderson
021 Bastrop
029 Bexar
037 Bowie
055 Caldwell
063 Camp
067 Cass
073 Cherokee
159 Franklin
161 Freestone
213 Henderson
287 Lee
289 Leon
331 Milam
343 Morris
379 Rains
395 Robertson
449 Titus
467 Van Zandt
499 Wood

Appendix table 1—Counties included in Coal Production Areas—Continued

GULF REGION—Cont'd.

TX-2
183 Gregg
203 Harrison
315 Marion
365 Panola
401 Rusk
419 Shelby

TX-3
005 Angelina
041 Brazos
051 Burleson
149 Fayette
185 Grimes
225 Houston
313 Madison
347 Nacogdoches
455 Trinity
471 Walker
477 Washington

PACIFIC REGION

AK-1
040 Barrow

AK-2
090 Fairbanks
240 SE Fairbanks
290 Yukon Koyukuk

AK-3
170 Matanuska-Susitna

AK-4
120 Kenai-Cook Inlet
210 Seward

WA-1
073 Whatcom

WA-2
033 King
037 Kittitas
053 Pierce

WA-3
041 Lewis
067 Thurston

Appendix table 2—Coal production, by region and type of mining, 1932-79

Region and type of mining	1932	1935	1940	1945	1950	1955	1960	1965	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979[1]
	Million tons																	
Northern Great Plains:																		
Deep	6.3	7.5	8.2	11.6	6.1	1.8	0.4	0.2	0.2	0.2	0.5	0.4	0.5	0.4	0.5	0.7	0.7	0.7
Surface	1.8	2.4	2.8	5.3	6.0	5.5	4.5	6.2	16.2	21.0	25.3	32.1	41.7	53.6	67.6	84.6	98.2	117.6
Total	8.1	9.9	11.0	16.9	12.1	7.3	4.9	6.4	16.3	21.2	25.8	32.5	42.3	54.1	68.2	85.3	99.0	118.3
Rocky Mountain:																		
Deep	9.7	10.2	11.3	15.7	11.3	9.7	8.1	8.9	9.5	8.9	8.9	9.6	9.6	11.2	12.1	13.6	14.2	15.1
Surface	*	*	*	.1	.4	.4	.7	4.0	8.7	10.4	12.7	14.5	18.9	19.8	25.5	29.1	30.4	36.8
Total	9.7	10.3	11.3	15.8	11.7	10.1	8.9	13.0	18.3	19.3	21.5	24.0	28.6	31.0	37.6	42.7	44.6	51.9
Interior:																		
Deep	52.0	62.2	61.2	87.4	63.2	48.3	41.6	41.9	54.6	47.9	52.2	56.1	54.9	57.6	55.7	53.6	43.4	52.9
Surface	16.5	18.6	30.1	45.3	47.9	48.1	57.1	78.4	95.4	88.4	101.3	93.4	87.6	93.5	92.2	94.3	82.8	91.3
Total	68.5	80.8	91.3	132.7	111.1	96.4	98.7	120.4	149.9	136.3	153.5	149.5	142.5	151.1	147.9	147.9	126.2	144.1
Eastern:																		
Deep	219.5	265.8	334.1	351.3	311.1	283.8	234.5	279.6	274.8	219.0	242.6	233.3	212.4	224.0	226.6	198.1	183.9	232.8
Surface	1.1	2.5	10.2	59.1	68.9	65.9	67.6	91.8	143.0	154.5	144.7	141.5	165.4	172.4	179.4	195.5	185.9	190.5
Total	220.6	268.4	344.3	410.4	380.0	349.6	302.1	371.4	417.8	373.6	387.3	374.8	377.7	396.4	406.0	393.6	369.8	423.2
Gulf:																		
Deep	.6	.7	.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Surface	.1	.1	*	.1	*	0	0	0	0	0	4.0	6.9	7.7	11.0	14.1	15.9	20.0	26.6
Total	.7	.8	.6	.1	*	0	0	0	0	0	4.0	6.9	7.7	11.0	14.1	15.9	20.0	26.6
Pacific:																		
Deep	1.7	1.7	1.8	1.6	1.1	.8	.3	.1	*	*	*	*	*	*	*	0	0	*
Surface	*	0	*	.2	.2	.4	.7	.9	.6	1.8	3.3	3.9	4.6	4.5	4.8	5.8	5.4	5.7
Total	1.7	1.7	1.8	1.7	1.3	1.3	1.0	.9	.6	1.8	3.3	4.0	4.6	4.5	4.8	5.8	5.4	5.7
U.S. total:[2]																		
Deep	289.7	348.1	417.1	467.5	392.8	344.4	285.0	330.7	339.1	276.1	304.1	299.4	277.5	293.2	294.9	265.9	242.2	301.4
Surface	19.5	23.6	43.2	110.0	123.4	120.2	130.5	181.4	263.8	276.1	291.3	292.4	325.9	354.8	383.6	425.2	423.0	468.6
Total	309.2	371.7	460.3	577.5	516.2	464.6	415.5	512.1	602.9	552.2	595.4	591.7	603.4	648.1	678.5	691.1	665.1	770.0

*Less than 50,000 tons.
[1] Preliminary data.
[2] Includes production from States not in any region.

Sources: (*90, 103, 105*).

Appendix table 3–Coal production, by region, State, and Coal Production Area (CPA), 1978

Region, State, and CPA	Production		
	Deep	Strip	Total
	Thousand tons		
Northern Great Plains (NGP):			
MT-2	0	302	302
MT-4	0	26,290	26,290
MT-5	0	8	8
Total MT	0	26,600	26,600
ND-1	0	1,325	1,325
ND-2	0	9,544	9,544
ND-3	0	3,159	3,159
Total ND	0	14,028	14,028
WY-1	0	2,861	2,861
WY-2	0	29,204	29,204
WY-3	414	15,415	15,829
WY-4	294	10,136	10,430
Not in CPA's	0	5	5
Total WY	708	57,620	58,328
NGP total	708	98,248	98,956
Rocky Mountain (RM):			
AZ-1	0	9,054	9,054
CO-1	594	8,244	9,838
CO-2	0	706	706
CO-3	42	81	123
CO-4	3,167	143	3,310
CO-5	66	48	114
CO-6	569	79	648
CO-7	73	0	73
Total CO	4,511	9,303	13,814
NM-1	0	8,825	8,825
NM-2	0	3,142	3,142
NM-3	576	89	665
Total NM	576	12,056	12,632
UT-1	9,141	0	9,141
RM total	14,228	30,413	44,641
Interior:			
AR-1	3	507	510
Not in CPA's	0	9	9
Total AR	3	516	519
IL-1	0	3,800	3,800
IL-3	6,928	0	6,928
IL-4	1,942	87	2,029
IL-5	4,452	16,807	21,259
IL-6	11,518	3,069	14,587
Total IL	24,841	23,760	48,600

Region, State, and CPA	Production		
	Deep	Strip	Total
	Thousand tons		
Interior (continued):			
IN-1	0	1,458	1,457
IN-2	0	4,597	4,597
IN-3	552	17,570	18,121
Not in CPA's	0	6	6
Total IN	552	23,630	24,182
IA-1	108	334	442
IA-2	0	9	9
Total IA	108	342	450
KS-3	0	1,226	1,226
KY-1	17,860	21,475	39,335
Not in CPA's	0	119	119
Total KY-1	17,860	21,596	39,456
MO-1	0	842	842
MO-3	0	1,821	1,821
MO-4	0	1,202	1,202
MO-5	0	1,800	1,800
Total MO	0	5,665	5,665
OK-1	0	5,018	5,018
OK-2	2	635	637
OK-3	0	416	416
Total OK	2	6,068	6,070
Interior total	43,366	82,803	126,168
Eastern:			
AL-1	6,169	13,822	19,991
Not in CPA's	0	561	561
Total	6,169	14,383	20,553
KY-2	0	2,487	2,487
KY-3	1,871	20,004	21,875
KY-4	24,929	16,247	41,176
KY-5	12,133	9,617	21,750
KY-6	61	1,066	1,127
Not in CPA's	2,637	5,186	7,817
Total KY	41,624	54,608	96,233
MD-1	382	2,616	2,998
OH-1	9,682	24,135	33,817
OH-2	0	811	811
OH-3	0	846	846
OH-4	2,214	3,541	5,755
Not in CPA's	0	8	8
Total OH	11,897	29,340	41,237

Continued–

Appendix table 3–Coal production, by region, State, and Coal Production Area (CPA), 1978–Continued

Region, State, and CPA	Production		
	Deep	Strip	Total
	Thousand tons		
Eastern (continued):			
PA-1	15,303	8,379	23,682
PA-2	17,624	40,172	57,796
Total PA	32,925	48,551	81,477
TN-1	2,915	5,054	7,969
TN-2	1,235	827	2,062
Total TN	4,150	5,882	10,032
VA-1	21,511	10,435	31,946
WV-1	5,900	268	6,168
WV-2	17,286	7,668	24,954
WV-3	1,209	1,109	2,318
WV-4	164	684	848
WV-5	19,266	6,329	25,595
WV-6	21,389	4,042	25,431
Total WV	65,216	20,099	85,314
Eastern total	183,876	185,914	369,790
Gulf:			
TX-1	0	12,483	12,483
TX-2	0	6,336	6,336
Not in CPA's	0	1,201	1,201
Total TX	0	20,020	20,020
Gulf total	0	20,020	20,020
Pacific:			
AK-2	0	731	731
WA-2	0	14	14
WA-3	0	4,694	4,694
Total WA	0	4,708	4,708
Pacific total	0	5,439	5,439
U.S. total[1]	242,177	422,950	665,127

[1] Includes 113,000 tons from Georgia.

Appendix table 4—Land in public ownership in Coal Production Areas (CPA's), by agency[1]

Region, State, and CPA	Bureau of Land Management	Forest Service[1]	Recreation and wildlife[2]	Military[3]	Other Federal agencies	Total Federal[4]	Indian land[5]	State[6]	Private[7]	Total land area[4 8]
	1,000 acres									
Northern Great Plains: (NGP):										
MT-1	*	–	29	–	–	29	51	46	958	1,084
MT-2	272	–	2	–	4	279	533	289	4,888	5,989
MT-3	653	–	–	70	*	724	2	166	1,884	2,776
MT-4	894	96	47	251	7	1,295	1,850	543	7,439	11,127
MT-5	600	340	*		59	999	–	279	3,230	4,508
ND-1	10	504	147	349	11	1,021	203	230	8,162	9,616
ND-2	21	386	66	137	6	616	227	158	5,049	6,050
ND-3	33	139	1	7	13	193	*	121	4,482	4,796
SD-1	39	229	–	157	13	438	1,396	426	4,372	6,632
WY-1	51	395	–	5	1	452	–	132	1,036	1,620
WY-2	748	485	–	3	–	1,236	–	434	4,045	5,715
WY-3	2,225	893	1	–	69	3,188	–	598	4,013	7,799
WY-4	5,531	990	16	–	4	6,541	–	325	2,424	9,290
NGP total[4]	11,078	4,457	309	979	187	17,011	4,262	3,747	51,982	77,003
Rocky Mountain (RM):										
AZ-1	813	4,230	866	29	98	6,036	13,496	2,218	3,607	25,357
CO-1	1,496	625	163	–	47	2,331	–	257	1,938	4,526
CO-2	188	334	12	–	*	534	–	123	381	1,038
CO-3	422	751	–	–	5	1,178	–	159	1,046	2,383
CO-4	4,032	3,338	31	56	163	7,620	–	12	3,687	11,319
CO-5	228	1,061	52	–	24	1,365	766	19	1,140	3,290
CO-6	86	215	–	–	3	304	–	227	3,544	4,075
CO-7	19	532	25	183	64	823	–	481	6,129	7,433
NM-1	976	–	21	–	*	997	2,272	107	144	3,520
NM-2	807	580	22	–	*	1,409	2,522	223	1,714	5,868
NM-3	*	12	3	–	–	15	–	209	2,185	2,409
NM-4	947	631	279	39	8	1,904	63	485	1,774	4,226
UT-1	2,790	959	10	–	5	3,764	*	437	819	5,020
UT-2	1,343	270	58	89	9	1,769	427	231	445	2,872
UT-3	4,222	1,326	337	–	691	6,576	–	580	235	7,391
RM total[4]	18,369	14,863	1,879	396	1,118	36,625	19,546	5,767	28,790	90,728
Interior:										
AR-1		933					–			3,095
IL-1		–					–			5,577
IL-2		–					–			4,514
IL-3		–					–			5,878
IL-4		–					–			2,115
IL-5		43					–			2,831
IL-6		24					–			3,610
IN-1	–	–					–			707
IN-2	–	–					–			1,040
IN-3	–	65					–			3,155
IA-1	–	–					–			1,520
IA-2	–	–					–			7,487

See footnotes at end of table.

Appendix table 4—Land in public ownership in Coal Production Areas (CPA's), by agency—Continued

Region, State, and CPA	Bureau of Land Management	Forest Service[1]	Recreation and wildlife[2]	Military[3]	Other Federal agencies	Total Federal[4]	Indian land[5]	State[6]	Private[7]	Total land area[4 8]
					1,000 acres					
KS-1		–					6			1,394
KS-2		–					–			822
KS-3		–					–			2,281
KY-1	–	–					–			3,823
MO-1		–					–			3,434
MO-2		–					–			2,580
MO-3		3					–			4,487
MO-4		–					–			2,325
MO-5		–					–			2,506
OK-1		–					90			3,767
OK-2		202					38			1,829
OK-3		–					44			2,237
Interior total[4]		1,270					179			73,014
Eastern:										
AL-1		97					–			6,337
KY-2	–	–					–			598
KY-3	–	324					–			3,634
KY-4	–	1					–			1,349
KY-5	–	98					–			1,310
KY-6	–	155					–			670
MD-1	–	–					–			696
OH-1		32					–			4,749
OH-2		32					–			934
OH-3		31					–			592
OH-4		75					–			1,791
PA-1	–	–					–			3,271
PA-2	–	247					–			11,560
TN-1	–	–					–			2,840
TN-2	–	–					–			2,205
VA-1	–	91					–			2,072
WV-1	–	–					–			372
WV-2	–	304					–			3,182
WV-3	–	111					–			787
WV-4	–	65					–			1,388
WV-5	–	–					–			2,970
WV-6	–	310					–			3,637
Eastern total[4]		1,974								56,943

See footnotes at end of table.

Continued—

Appendix table 4—Land in public ownership in Coal Production Areas (CPA's), by agency—Continued

Region, State and CPA	Bureau of Land Management	Forest Service[1]	Recreation and wildlife[2]	Military[3]	Other Federal agencies	Total Federal[4]	Indian land[5]	State[6]	Private[7]	Total land area[4 8]
	1,000 acres									
Gulf:										
AL-2	–	–	–	95	8	102	–			4,552
AR-2	–	53	–	8	*	60	–			2,257
TX-1	–	–	–	185	1	186	–			9,616
TX-2	–	68	–	31	*	100	–			2,650
TX-3	–	284	–	87	*	371	–			5,401
Gulf total[4]		404		405	9	819				24,476
Pacific:										
AK-1										
AK-2										
AK-3										
AK-4										
WA-1	*	482	392	*	*	874	10	76	401	1,361
WA-2	16	869	235	185	14	1,320	2	235	2,361	3,917
WA-3	*	441	*	18	*	459	2	171	1,376	2,008
Pacific total[4 9]	17	1,792	627	203	14	2,653	13	482	4,137	7,286
Total, all CPA's[4 9]	29,464	24,760					24,000			329,450

A blank space indicates that data are not uniformly available by counties, hence not available for CPA's.
*Less than 500 acres.
–Zero.
[1] Includes National Forests and National Grasslands (*80, 81*).
[2] National Park Service and Fish and Wildlife Services.
[3] Includes military installations and Corps of Engineers project areas.
[4] Detail may not add to total because of rounding.
[5] Includes land owned by Indian tribes, allotments to individual Indians, and some Federal land owned by the Bureau of Indian Affairs (*93*).
[6] Includes land granted to States for school purposes and some State parks and State forests.
[7] Obtained by subtracting data in columns to the left from the total.
[8] Excludes water areas. From U.S. Census of Agriculture (*84*).
[9] Excludes Alaska (see text).

Sources: (*94, 122*), except as noted.

Appendix table 5—Land area and major land use in Coal Production Areas (CPA's), 1974

Region, State, and CPA	Land area	Nonfarm land	Land in farms							
			Cropland				Woodland	Pasture, range, and other	Total	Irrigated
			Harvested	Pastured	Other	Total				
	1,000 acres									
Northern Great Plains:										
MT-1	1,084	−40	360	19	305	684	4	437	1,124	1
MT-2	5,989	448	1,058	99	848	2,005	22	3,514	5,541	53
MT-3	2,776	539	303	21	266	590	3	1,644	2,237	11
MT-4	11,127	1,586	410	71	204	685	323	8,534	9,541	97
MT-5	4,508	418	177	23	79	278	36	3,775	4,090	39
ND-1	9,616	923	3,282	420	2,240	5,942	83	2,668	8,693	41
ND-2	6,050	102	1,558	347	531	2,436	85	3,427	5,948	11
ND-3	4,796	53	1,548	301	860	2,709	37	1,998	4,743	3
SD-1	6,632	299	797	126	244	1,168	25	5,140	6,333	5
WY-1	1,620	149	72	34	8	115	6	1,350	1,471	56
WY-2	5,715	683	103	36	38	178	13	4,841	5,032	50
WY-3	7,799	2,731	144	53	12	208	31	4,829	5,068	185
WY-4	9,290	6,955	110	40	5	155	242	1,938	2,335	108
NGP total	77,003	14,846	9,922	1,590	5,641	17,152	910	44,095	62,157	660
Rocky Mountain:										
AZ-1	25,357	6,164	25	24	25	74	3,471	15,648	19,193	26
CO-1	4,526	2,730	132	37	84	253	69	1,473	1,797	68
CO-2	1,038	567	75	18	2	95	12	364	470	91
CO-3	2,383	1,612	26	11	7	44	39	688	772	41
CO-4	11,319	8,759	299	179	37	515	116	1,929	2,560	377
CO-5	3,290	1,728	144	87	23	254	358	950	1,562	116
CO-6	4,075	1,247	44	32	30	106	59	2,663	2,829	22
CO-7	7,433	1,639	1,072	217	649	1,938	71	3,785	5,794	463
NM-1	3,520	1,608	22	13	4	39	127	1,746	1,912	29
NM-2	5,868	1,715	8	13	16	39	718	3,398	4,153	9
NM-3	2,409	140	17	30	16	63	536	1,670	2,269	13
NM-4	4,226	2,328	13	11	5	29	6	1,863	1,898	16
UT-1	5,020	4,239	60	38	8	106	32	644	782	82
UT-2	7,391	6,958	23	26	4	53	13	367	433	34
UT-3	2,872	1,464	31	26	16	73	461	874	1,408	52
RM total	90,728	42,896	1,991	762	926	3,679	6,090	38,063	47,832	1,436
Interior:										
AR-1	3,095	2,035	189	332	19	539	248	273	1,060	9
IL-1	5,577	732	3,233	398	168	3,799	453	593	4,845	3
IL-2	4,514	565	3,387	123	69	3,578	118	253	3,949	11
IL-3	5,878	763	3,831	288	156	4,276	340	499	5,114	2
IL-4	2,115	180	1,559	77	49	1,686	111	139	1,935	*
IL-5	2,831	699	1,465	144	105	1,714	227	191	2,132	3
IL-6	3,610	1,030	1,714	236	158	2,108	212	259	2,579	4
IN-1	707	171	341	41	17	399	86	51	536	*
IN-2	1,040	398	386	54	40	481	87	75	642	1
IN-3	3,155	1,053	1,280	221	92	1,593	273	236	2,102	2

See footnotes at end of table.

Continued—

Appendix table 5—Land area and major land use in Coal Production Areas (CPA's), 1974—Continued

Region, State, and CPA	Land area	Nonfarm land	Land in farms							
			Cropland				Woodland	Pasture, range, and other	Total	Irrigated
			Harvested	Pastured	Other	Total				
	1,000 acres									
Interior—Continued:										
IA-1	1,520	232	677	229	40	946	96	247	1,288	*
IA-2	7,487	753	4,510	744	134	5,388	382	964	6,734	1
KS-1	1,394	156	655	196	42	894	58	286	1,238	2
KS-2	822	127	301	89	18	407	36	251	694	2
KS-3	2,281	377	763	240	46	1,050	78	776	1,904	2
KY-1	3,823	1,430	968	520	104	1,591	461	341	2,393	1
MO-1	3,434	505	1,198	763	75	2,035	221	673	2,930	*
MO-2	2,580	391	1,133	443	81	1,657	153	379	2,189	2
MO-3	4,487	941	1,645	708	131	2,484	446	616	3,546	6
MO-4	2,325	506	758	442	40	1,240	180	399	1,819	2
MO-5	2,506	547	855	424	47	1,327	166	466	1,959	13
OK-1	3,767	1,288	454	511	48	1,013	204	1,262	2,479	4
OK-2	1,829	988	110	219	12	341	167	332	841	3
OK-3	2,237	805	89	252	13	354	261	816	1,431	3
Interior total	73,014	16,673	31,500	7,694	1,707	40,900	5,064	10,377	56,341	78
Eastern:										
AL-1	6,337	4,661	378	348	63	790	579	307	1,676	1
KY-2	598	407	17	38	8	64	88	39	191	*
KY-3	3,634	2,260	149	345	68	562	589	224	1,375	*
KY-4	1,349	1,304	3	6	1	10	27	8	45	*
KY-5	1,310	1,237	8	18	3	29	26	18	73	*
KY-6	670	423	40	64	7	111	101	35	247	*
MD-1	696	521	44	28	4	72	69	31	176	*
OH-1	4,749	2,611	837	345	91	1,272	384	481	2,138	2
OH-2	934	553	78	75	13	166	98	117	381	*
OH-3	592	443	33	29	6	67	46	35	149	*
OH-4	1,791	1,230	121	111	22	254	162	146	562	1
PA-1	3,271	2,337	338	177	52	568	172	194	934	1
PA-2	11,560	8,902	1,068	364	118	1,549	718	390	2,658	2
TN-1	2,840	2,111	113	213	22	349	292	88	729	*
TN-2	2,205	1,534	121	206	20	347	232	93	671	*
VA-1	2,072	1,427	80	140	19	239	207	199	646	*
WV-1	372	257	24	28	6	57	31	26	115	*
WV-2	3,182	2,331	128	212	18	357	298	196	851	*
WV-3	787	543	28	41	4	73	113	58	244	*
WV-4	1,388	1,119	29	72	5	106	111	52	268	*
WV-5	2,970	2,651	42	73	13	129	125	66	320	*
WV-6	3,637	3,119	66	91	10	167	210	141	518	*
Eastern total	56,943	41,980	3,744	3,026	572	7,342	4,678	2,944	14,964	9
Gulf:										
AL-2	4,552	2,552	364	321	68	753	773	474	2,000	1

See footnotes at end of table.

Continued—

Appendix table 5—Land area and major land use in Coal Production Areas (CPA's), 1974—Continued

Region, State, and CPA	Land area	Nonfarm land	Land in farms							
			Cropland				Woodland	Pasture, range, and other	Total	Irrigated
			Harvested	Pastured	Other	Total				
			1,000 acres							
AR-2	2,257	1,927	94	81	13	187	87	56	330	7
TX-1	9,616	3,986	655	1,432	121	2,208	1,046	2,376	5,630	49
TX-2	2,650	1,576	78	329	16	423	313	338	1,074	2
TX-3	5,401	2,282	319	789	50	1,158	588	1,372	3,119	19
Gulf total	24,476	12,324	1,510	2,952	269	4,730	2,806	4,616	12,152	78
Pacific:										
AK-1[1]	36,856	36,856	0	0	0	0	0	0	0	0
AK-2[1]	152,668	152,498	5	*	4	10	6	155	170	*
AK-3[1]	38,884	38,608	10	1	1	12	9	256	276	*
AK-4[1]	10,369	10,316	2	*	*	2	9	42	53	*
WA-1	1,361	1,228	66	27	2	94	16	23	133	25
WA-2	3,917	3,347	80	65	6	151	80	340	570	76
WA-3	2,008	1,805	51	42	5	99	75	28	202	13
Pacific total[2]	7,286	6,380	197	134	13	344	171	391	905	114
Total, all CPA's[2]	329,450	135,099	48,864	16,158	9,128	74,174	19,719	100,486	194,351	2,375

*Less than 500 acres.
[1] Small area data for Alaska not available. Data shown are for Census groupings of districts, each of which is much larger than any CPA.
[2] Excluding Alaska.

Note: Data may not add to total because of rounding.

Source: (*84*).

Appendix table 6—Land use ratios for Coal Production Areas (CPA's), 1974

Region, State, and CPA	Farmland to land area	Cropland to farmland	Harvested cropland to total cropland	Harvested cropland to land area
		Percent		
Northern Great Plains:				
MT-1	103.7	60.8	52.7	33.2
MT-2	92.5	36.2	52.8	17.7
MT-3	80.6	26.4	51.3	10.9
MT-4	85.7	7.2	59.8	3.7
MT-5	90.7	6.8	63.4	3.9
ND-1	90.4	68.4	55.2	34.1
ND-2	98.3	41.0	63.9	25.7
ND-3	98.9	57.1	57.2	32.3
SD-1	95.5	18.4	68.3	12.0
WY-1	90.8	7.8	63.0	4.5
WY-2	88.0	3.5	58.0	1.8
WY-3	65.0	4.1	69.0	1.8
WY-4	25.1	6.6	71.1	1.2
Northern Great Plains average	80.7	26.3	57.8	12.9
Rocky Mountain:				
AZ-1	75.7	3.7	33.7	.1
CO-1	39.7	14.1	52.2	2.9
CO-2	45.3	20.1	79.6	7.3
CO-3	32.4	5.7	59.3	1.1
CO-4	22.6	20.1	58.1	2.6
CO-5	47.5	16.2	56.7	4.4
CO-6	69.4	3.8	41.3	1.1
CO-7	77.9	33.4	55.3	14.4
NM-1	54.3	2.0	56.5	.6
NM-2	70.8	.9	21.9	.1
NM-3	94.2	2.8	26.3	.7
NM-4	44.9	1.5	45.2	.3
UT-1	15.6	13.5	56.4	1.2
UT-2	5.9	12.3	43.0	.3
UT-3	49.0	5.2	42.6	1.1
Rocky Mountain average	52.7	7.7	54.1	2.2
Interior:				
AR-1	34.2	50.8	35.0	6.1
IL-1	86.9	78.4	85.1	58.0
IL-2	87.5	90.6	94.6	75.0
IL-3	87.0	83.6	89.6	65.2
IL-4	91.5	87.1	92.5	73.7
IL-5	75.3	80.4	85.5	51.7
IL-6	71.5	81.7	81.3	47.5

Continued—

Appendix table 6—Land use ratios for Coal Production Areas (CPA's), 1974—Continued

Region, State, and CPA	Farmland to land area	Cropland to farmland	Harvested cropland to total cropland	Harvested cropland to land area
	Percent			
Interior—Continued:				
IN-1	75.8	74.4	85.4	48.2
IN-2	61.7	74.8	80.4	37.1
IN-3	66.6	75.8	80.4	40.6
IA-1	84.7	73.4	71.6	44.5
IA-2	89.9	80.0	83.7	60.2
KS-1	88.8	72.2	73.3	47.0
KS-2	84.5	58.6	73.8	36.6
KS-3	83.5	55.1	72.7	33.5
KY-1	62.6	66.5	60.8	25.3
MO-1	85.3	69.5	58.8	34.9
MO-2	84.9	75.7	68.4	43.9
MO-3	79.0	70.1	66.2	36.7
MO-4	78.2	68.2	61.1	32.6
MO-5	78.2	67.7	64.5	34.1
OK-1	67.5	40.9	44.8	12.0
OK-2	46.0	40.5	32.3	6.0
OK-3	64.0	24.7	25.0	4.0
Interior average	77.2	72.6	77.0	43.1
Eastern:				
AL-1	26.4	47.1	47.9	6.0
KY-2	31.9	33.4	27.3	2.9
KY-3	37.8	40.9	26.5	4.1
KY-4	3.3	23.1	27.7	.2
KY-5	5.6	40.2	28.4	.6
KY-6	36.9	44.9	35.7	5.9
MD-1	25.2	43.2	57.6	6.3
OH-1	45.0	59.5	65.8	17.6
OH-2	40.8	43.5	46.7	8.3
OH-3	25.2	45.3	48.5	5.5
OH-4	31.4	45.3	47.8	6.8
PA-1	28.5	60.8	59.5	10.3
PA-2	23.0	58.3	68.9	9.2
TN-1	25.7	47.9	32.5	4.0
TN-2	30.4	51.7	34.9	5.5
VA-1	31.2	37.1	33.5	3.9

—Continued—

Appendix table 6–Land use ratios for Coal Production Areas (CPA's), 1974–Continued

Region, State, and CPA	Farmland to land area	Cropland to farmland	Harvested cropland to total cropland	Harvested cropland to land area
	Percent			
Eastern–Continued:				
WV-1	30.8	49.8	41.4	6.4
WV-2	26.7	42.0	35.8	4.0
WV-3	31.0	29.9	37.8	3.5
WV-4	19.3	39.4	27.4	2.1
WV-5	10.8	40.3	33.0	1.4
WV-6	14.2	32.2	39.4	1.8
Eastern average	26.3	49.1	51.0	6.6
Gulf:				
AL-2	43.9	37.7	48.3	8.0
AR-2	14.6	56.7	50.1	4.2
TX-1	58.5	39.2	29.7	6.8
TX-2	40.5	39.4	18.5	3.0
TX-3	57.7	37.1	27.5	5.9
Gulf average	49.6	38.9	31.9	6.2
Pacific:				
AK-1[1]	N	N	N	N
AK-2[1]	N	5.6	49.7	N
AK-3[1]	N	4.4	83.5	N
AK-4[1]	N	3.8	80.5	N
WA-1	9.8	71.0	69.7	4.8
WA-2	14.6	26.4	53.2	2.0
WA-3	10.1	48.8	52.2	2.6
Pacific average[1]	12.5	37.9	57.3	2.7
All CPA's average[1]	59.0	38.2	65.9	14.8

[1] Excluding Alaska.

N = No meaningful figure.

Source: (*84*).

Appendix table 7—Three leading crops in each Coal Production Area (CPA), 1974

Region, State, and CPA	Cropland harvested[1]	First		Second		Third	
	1,000 acres	*Crop*	*Percent*	*Crop*	*Percent*	*Crop*	*Percent*
Northern Great Plains:							
MT-1	360	Wheat	82.3	Hay	9.4	Small grains[2]	8.5
MT-2	1,058	Wheat	68.1	Hay	15.9	Small grains	13.2
MT-3	303	Wheat	70.3	Hay	14.2	Small grains	13.8
MT-4	410	Wheat	42.0	Hay	34.7	Small grains	15.4
MT-5	177	Hay	50.6	Wheat	28.3	Small grains	10.9
ND-1	3,282	Wheat	66.9	Hay	19.5	Small grains	13.4
ND-2	1,558	Wheat	40.7	Hay	36.7	Small grains	18.3
ND-3	1,548	Wheat	54.4	Hay	27.4	Small grains	15.8
SD-1	797	Hay	43.5	Wheat	38.8	Small grains	13.7
WY-1	72	Hay	77.3	Small grains	13.9	Wheat	8.0
WY-2	103	Hay	62.4	Wheat	25.8	Small grains	11.8
WY-3	144	Hay	90.0	Wheat	4.8	Small grains	4.2
WY-4	110	Hay	81.1	Small grains	18.0	Wheat	1.6
Northern Great Plains total or percent	9,922	Wheat	55.2	Hay	28.2	Small grains	14.3
Rocky Mountain:							
AZ-1	25	Hay	43.9	Corn	37.1	Orchards	5.2
CO-1	132	Hay	50.0	Wheat	43.5	Small grains	6.1
CO-2	75	Hay	100.0	–	–	–	–
CO-3	26	Hay	95.6	Corn	1.4	Wheat	1.4
CO-4	299	Hay	65.2	Corn	17.3	Small grains	7.9
CO-5	144	Dry beans	35.4	Hay	32.6	Wheat	27.1
CO-6	44	Hay	55.3	Wheat	34.2	Sorghum	5.2
CO-7	1,072	Wheat	50.0	Hay	19.1	Corn	17.7
NM-1	22	Hay	76.5	Corn	13.2	Wheat	2.3
NM-2	8	Hay	60.7	Corn	16.3	Vegetables	W
NM-3	17	Hay	87.5	Wheat	8.0	Small grains	2.9
NM-4	13	Hay	59.2	Sorghum	19.6	Corn	15.2
UT-1	60	Hay	67.1	Small grains	14.9	Corn	12.3
UT-2	23	Hay	80.4	Small grains	12.4	Wheat	4.0
UT-3	31	Hay	70.5	Corn	13.5	Wheat	7.3
Rocky Mountain total or percent	1,991	Hay	38.2	Wheat	34.8	Corn	12.6
Interior:							
AR-1	189	Hay	58.1	Soybeans	32.2	Wheat	4.4
IL-1	3,233	Corn	55.3	Soybeans	32.0	Hay	6.4
IL-2	3,387	Corn	54.5	Soybeans	39.8	Hay	2.2
IL-3	3,831	Corn	43.8	Soybeans	43.3	Wheat	9.8
IL-4	1,559	Soybeans	45.5	Corn	44.0	Wheat	7.8
IL-5	1,465	Soybeans	39.2	Corn	27.3	Wheat	25.7
IL-6	1,714	Soybeans	48.6	Corn	26.1	Wheat	20.4

See footnotes at end of table.

Continued—

Appendix table 7—Three leading crops in each Coal Production Area (CPA), 1974—Continued

Region, State, and CPA	Cropland harvested[1]	First		Second		Third	
	1,000 acres	*Crop*	*Percent*	*Crop*	*Percent*	*Crop*	*Percent*
Interior—Continued:							
IN-1	341	Corn	46.1	Soybeans	36.8	Wheat	10.7
IN-2	386	Corn	39.7	Soybeans	38.1	Wheat	15.6
IN-3	1,280	Corn	48.0	Soybeans	28.4	Wheat	16.5
IA-1	677	Corn	48.1	Soybeans	28.9	Hay	17.2
IA-2	4,510	Corn	53.2	Soybeans	34.4	Hay	8.7
KS-1	655	Corn	31.2	Sorghum	24.8	Soybeans	15.3
KS-2	301	Soybeans	28.5	Sorghum	22.0	Hay	21.9
KS-3	763	Wheat	33.1	Soybeans	25.9	Hay	17.8
KY-1	968	Soybeans	39.6	Corn	38.4	Hay	15.3
MO-1	1,198	Corn	34.9	Hay	32.4	Soybeans	29.2
MO-2	1,133	Soybeans	38.6	Corn	36.1	Hay	16.5
MO-3	1,645	Soybeans	41.6	Corn	26.1	Hay	20.7
MO-4	758	Hay	27.6	Soybeans	24.3	Corn	21.1
MO-5	855	Soybeans	27.2	Hay	22.3	Wheat	19.7
OK-1	454	Hay	43.9	Soybeans	25.1	Wheat	14.4
OK-2	110	Hay	57.5	Soybeans	29.8	Wheat	7.0
OK-3	89	Hay	74.4	Sorghum	6.6	Wheat	3.3
Interior total or percent	31,500	Corn	40.4	Soybeans	36.2	Hay	11.1
Eastern:							
AL-1	378	Corn	28.6	Hay	23.5	Soybeans	23.5
KY-2	17	Hay	58.0	Corn	27.6	Soybeans	7.5
KY-3	149	Hay	59.3	Corn	30.4	Tobacco	9.4
KY-4	3	Hay	54.3	Corn	39.7	Soybeans	3.1
KY-5	8	Hay	61.3	Corn	32.2	Tobacco	3.0
KY-6	40	Hay	49.7	Corn	31.5	Wheat	7.3
MD-1	44	Hay	56.8	Corn	22.0	Small grains	13.5
OH-1	837	Hay	40.4	Corn	37.4	Small grains	9.8
OH-2	78	Hay	64.6	Corn	25.2	Wheat	5.0
OH-3	33	Hay	58.6	Corn	27.4	Wheat	4.7
OH-4	121	Hay	49.3	Corn	31.1	Soybeans	9.7
PA-1	338	Hay	51.8	Corn	28.4	Small grains	14.1
PA-2	1,068	Hay	52.9	Corn	29.1	Small grains	14.1
TN-1	113	Hay	63.2	Corn	22.4	Vegetables	8.3
TN-2	121	Hay	53.4	Corn	25.0	Soybeans	12.7
VA-1	80	Hay	71.1	Corn	21.6	Tobacco	6.0
WV-1	24	Hay	78.0	Corn	12.8	Small grains	4.6
WV-2	128	Hay	88.4	Corn	9.0	Small grains	2.2
WV-3	28	Hay	76.7	Corn	16.8	Small grains	3.1

See footnotes at end of table.

Continued—

Appendix table 7—Three leading crops in each Coal Production Area (CPA), 1974—Continued

Region, State, and CPA	Cropland harvested[1]	First		Second		Third	
	1,000 acres	*Crop*	*Percent*	*Crop*	*Percent*	*Crop*	*Percent*
Eastern—Continued:							
WV-4	29	Hay	94.5	Corn	3.8	Orchards	.9
WV-5	42	Hay	61.6	Corn	28.0	Soybeans	4.0
WV-6	66	Hay	81.5	Corn	14.6	Small grains	2.2
Eastern total or percent	3,744	Hay	50.7	Corn	29.0	Small grains	8.1
Gulf:							
AL-2	364	Corn	31.6	Peanuts	25.0	Hay	17.8
AR-2	94	Soybeans	49.4	Hay	23.0	Cotton	19.0
TX-1	655	Hay	45.5	Sorghum	25.6	Cotton	10.3
TX-2	78	Hay	89.5	Vegetables	3.4	Corn	2.9
TX-3	319	Hay	56.3	Sorghum	19.9	Cotton	10.7
Gulf total or percent	1,510	Hay	41.2	Sorghum	15.6	Corn	11.7
Pacific:							
AK-1	0	–	–	–	–	–	–
AK-2 (Fairbanks)	5	Hay	47.8	Other[3]	38.1	Small grains	9.5
AK-3 (Anchorage)	10	Hay	[4]	Small grains	6.3	Potatoes	3.5
AK-4 (Ken./Cook)	2	Hay	96.0	Small grains	2.7	Potatoes	1.0
WA-1	66	Hay	71.1	Vegetables	17.8	Corn	9.7
WA-2	80	Hay	65.1	Wheat	11.3	Vegetables	9.1
WA-3	51	Hay	81.8	Vegetables	6.8	Small grains	5.7
Pacific total or percent	214	Hay	71.9	Vegetables	10.6	Corn	5.4

– = Not applicable.
W = Data withheld to prevent disclosure.
[1] Detail may not add to total because of rounding.
[2] All small grains includes oats, barley, rye, and mixed grains.
[3] "Other Crops" not identified as to kind.
[4] Data internally inconsistent—probably about 90 percent.

Source: (*84*).

Appendix table 8–Total gross farm sales per farm and per acre, 1974

Region, State, and Coal Production Area	Livestock	Crops	Total	Commercial farms	Other farms	Income per commercial farm	Average per acre of–	
							Land area	Farmland
	1,000 dollars					*Dollars*		
Northern Great Plains:								
MT-1	3,877	25,358	29,236	29,188	48	44,426	26.96	26.01
MT-2	42,322	81,615	123,936	123,690	246	55,194	20.69	22.37
MT-3	12,533	22,625	35,159	35,129	30	52,198	12.67	15.72
MT-4	50,637	32,858	83,496	83,320	176	63,700	7.50	8.75
MT-5	24,835	10,449	35,285	34,515	770	52,856	7.83	8.63
ND-1	55,308	240,649	295,956	295,282	674	37,420	30.78	34.05
ND-2	62,260	59,714	121,975	121,301	674	30,295	20.16	20.91
ND-3	47,173	82,923	130,098	129,795	303	38,153	27.13	27,43
SD-1	39,291	24,634	63,925	63,615	310	35,263	9.59	10.09
WY-1	10,975	1,870	12,844	12,689	155	35,845	7.93	8.73
WY-2	20,306	2,666	22,971	22,901	70	38,296	4.02	4.57
WY-3	25,897	2,415	28,312	28,240	72	62,340	3.63	5.59
WY-4	12,534	2,966	15,500	15,323	177	30,769	1.67	6.64
Northern Great Plains total or average	407,948	590,742	998,693	994,988	3,705	40,552	12.97	16.07
Rocky Mountain:								
AZ-1	24,514	1,578	26,091	14,159	11,932	38,898	1.03	1.36
CO-1	12,750	5,930	18,680	18,632	48	39,391	4.13	10.40
CO-2	4,101	1,430	5,531	5,526	5	63,517	5.33	11.39
CO-3	5,338	1,276	6,615	5,695	920	27,380	2.78	8.57
CO-4	58,361	33,874	92,236	90,840	1,396	36,927	8.15	36.03
CO-5	10,377	6,936	17,313	16,618	695	21,526	5.26	11.08
CO-6	10,335	1,469	11,804	11,614	190	26,276	2.90	4.17
CO-7	555,386	170,448	725,834	724,571	1,263	144,741	97.65	125.27
NM-1	2,888	2,697	5,585	3,517	2,068	17,585	1.59	2.92
NM-2	6,383	1,296	7,679	3,883	3,796	19,913	1.31	1.85
NM-3	10,869	1,084	11,953	11,840	113	58,614	4.96	5.27
NM-4	5,328	2,294	7,623	7,428	195	34,549	1.80	4.02
UT-1	14,955	3,127	18,082	17,661	421	26,558	3.60	23.12
UT-2	4,266	659	4,925	4,754	171	23,078	.67	11.37
UT-3	6,028	1,067	7,096	6,192	904	20,709	2.47	5.04
Rocky Mountain total or average	731,879	235,165	967,047	942,930	24,117	77,950	10.66	20.22
Interior:								
AR-1	106,517	15,000	121,516	118,451	3,065	45,523	39.26	114.63
IL-1	345,235	456,476	801,712	799,138	2,574	48,841	143.76	165.48
IL-2	129,403	588,853	718,255	716,726	1,529	55,273	159.10	181.88
IL-3	213,128	633,466	846,596	843,053	3,543	51,128	144.04	165.53
IL-4	50,752	257,439	308,192	307,192	1,000	50,434	145.69	159.25
IL-5	104,455	163,715	268,168	265,765	2,403	32,230	94.72	125.77
IL-6	66,600	191,056	257,651	254,974	2,677	29,752	71.38	99.89

Continued–

Appendix table 8—Total gross farm sales per farm and per acre, 1974—Continued

Region, State, and Coal Production Area	Livestock	Crops	Total	Commercial farms	Other farms	Income per commercial farm	Average per acre of—	
							Land area	Farmland
	1,000 dollars					*Dollars*		
Interior—Continued:								
IN-1	17,606	47,187	64,790	64,393	397	40,448	91.61	120.94
IN-2	18,433	50,443	68,874	67,611	1,263	28,564	66.21	107.25
IN-3	137,061	180,451	317,512	314,874	2,638	39,762	100.63	151.02
IA-1	112,159	63,094	175,253	174,105	1,148	37,036	115.29	136.05
IA-2	530,056	647,428	1,177,487	1,171,683	5,804	50,091	157.28	174.86
KS-1	59,962	49,784	109,747	107,645	2,102	31,256	78.74	88.64
KS-2	22,817	20,095	42,912	42,358	554	24,316	52.22	61.80
KS-3	65,808	58,865	124,674	123,301	1,373	30,864	54.65	65.47
KY-1	72,858	158,359	231,221	225,667	5,554	25,531	60.48	96.62
MO-1	116,244	91,250	207,493	204,777	2,716	26,116	60.42	70.83
MO-2	109,300	111,335	220,632	218,575	2,057	32,903	85,52	100.78
MO-3	146,480	148,663	295,141	291,003	4,138	29,045	65.77	83.23
MO-4	75,367	58,734	134,100	131,770	2,330	25,018	57.67	73.73
MO-5	72,105	67,854	139,960	137,590	2,370	25,771	55.86	71.45
OK-1	62,792	31,094	93,887	89,664	4,223	20,254	24.93	37.87
OK-2	18,825	7,708	26,533	24,707	1,826	17,241	14.51	31.56
OK-3	22,478	3,889	26,367	23,908	2,459	14,138	11.79	18.42
Interior total or average	2,676,441	4,102,238	6,778,673	6,718,930	59,743	39,069	92.84	120.31
Eastern:								
AL-1	261,883	52,670	314,552	307,278	7,274	44,462	14.63	187.69
KY-2	5,469	3,267	8,736	7,846	890	13,551	14.60	45.74
KY-3	27,006	36,441	63,447	54,706	8,741	9,564	17.46	46.16
KY-4	478	231	708	505	203	10,745	.52	15.74
KY-5	1,435	839	2,274	1,764	510	10,080	1.74	31.04
KY-6	7,688	6,792	14,480	13,141	1,339	11,568	21.60	58.61
MD-1	10,853	2,453	13,307	12,888	419	26,089	19.12	76.04
OH-1	164,484	68,252	232,735	225,680	7,055	25,512	49.01	108.86
OH-2	11,104	4,321	15,425	13,833	1,592	14,795	16.52	40.47
OH-3	3,818	1,913	5,731	5,151	580	13,997	9.68	38.48
OH-4	24,285	12,879	37,163	34,742	2,421	10,013	20.74	66.14
PA-1	58,846	34,128	92,973	88,533	4,440	23,502	28.42	99.58
PA-2	223,659	71,516	295,167	287,074	8,093	31,422	25.53	111.05
TN-1	24,666	14,279	38,944	34,345	4,599	13,089	13.71	53.45
TN-2	32,740	12,273	45,013	41,830	3,183	17,524	20.42	67.09
VA-1	15,535	12,471	28,007	23,822	4,185	10,644	13.51	43.38
WV-1	3,569	1,865	5,434	4,960	474	17,778	14.60	47.38
WV-2	16,369	4,745	21,113	17,521	3,592	12,874	6.64	24.82

Continued—

Appendix table 8–Total gross farm sales per farm and per acre, 1974–Continued

Region, State, and Coal Production Area	Livestock	Crops	Total	Commercial farms	Other farms	Income per commercial farm	Average per acre of–	
							Land area	Farmland
	1,000 dollars					*Dollars*		
Eastern–Continued:								
WV-3	5,777	1,285	7,062	6,463	599	18,519	8.98	28.94
WV-4	2,289	715	3,002	2,101	901	6,670	2.16	11.20
WV-5	8,068	4,491	12,559	10,489	2,070	15,797	4.23	39.30
WV-6	12,571	2,498	15,070	13,196	1,874	15,326	4.14	29.08
Eastern total or average	922,592	350,324	1,272,902	1,207,868	65,034	23,717	22.35	85.07
Gulf:								
AL-2	59,730	55,716	115,446	112,341	3,105	31,574	25.36	153.31
AR-2	16,459	12,432	28,893	27,854	1,039	40,251	12.80	154.51
TX-1	203,163	60,951	264,116	251,533	12,583	25,870	27.47	119.62
TX-2	80,471	5,479	85,948	82,818	3,130	37,474	32.43	203.19
TX-3	116,784	24,148	140,931	130,341	10,590	25,632	26.09	121.70
Gulf total or average	476,607	158,726	635,334	604,887	30,447	28,441	25.96	134.32
Pacific:								
AK-1	0	0	0	0	0	0	–	–
AK-2	666	965	1,631	1,577	54	35,841	.01	9.57
AK-3	2,847	1,624	4,472	4,336	136	41,692	.12	16.19
AK-4	82	255	337	320	17	12,308	.03	6.34
WA-1	41,825	12,965	54,790	54,177	613	52,856	40.27	412.20
WA-2	71,832	27,091	98,925	97,144	1,781	59,090	25.25	173.40
WA-3	35,887	9,317	45,205	44,317	888	56,671	22.52	223.47
Pacific total or average	153,139	52,217	205,360	201,871	3,489	92,512	.56	103.87

– = Not applicable.

Source: (*84*).

Appendix table 9–Projected coal production from surface mines, land used for mining, and value of production displaced, by region, State, and Coal Production Areas (CPA's), 1975-99

Region, State, and CPA	Average annual coal production, 1975-99[1]	New or expanded mines[1]	Coal yield per acre[2]	Average annual acreage taken out of production[3]	Value of production displaced		Ratio[6]
					Per acre[4]	Total[5]	
	Million tons	*Number*	*Tons*	*Acres*	*Dollars*	*1,000 dollars*	*Percent*
Northern Great Plains:							
MT-1	0	0	29,400	0	26.96	0	–
MT-2	.3	0	25,200	95	20.69	2	*
MT-3	1.8	1	22,528	1,439	12.67	18	0.05
MT-4	58.6	10	42,480	19,036	7.50	143	.17
MT-5	0	0	33,792	0	7.83	0	–
ND-1	8.6	5	11,200	7,839	30.78	241	.08
ND-2	20.7	5	16,800	10,161	20.16	205	.17
ND-3	4.9	3	22,400	3,494	27.13	95	.07
SD-1	0	0	7,000	0	9.59	0	–
WY-1	8.4	5	29,736	6,260	7.93	50	.39
WY-2	141.8	19	100,608	26,475	4.02	106	.46
WY-3	31.7	10	34,761	15,296	3.63	56	.20
WY-4	19.2	8	21,599	13,511	1.67	23	.15
Northern Great Plains total or average	296.0	66	47,870	103,606	9.06	939	.09
Rocky Mountain:							
AZ-1	11.7	1	14,160	9,063	1.03	9	.04
CO-1	9.1	3	16,416	7,943	4.13	33	.18
CO-2	2.4	2	34,560	2,294	5.33	12	.22
CO-3	0	0	8,640	0	2.78	0	–
CO-4	10.3	5	19,563	9,265	8.15	76	.08
CO-5	0	0	19,563	0	5.26	0	–
CO-6	.2	0	19,563	102	2.90	*	*
CO-7	0	0	19,563	0	97.65	0	–
NM-1	12.4	8	15,840	14,228	1.59	23	.41
NM-2	15.6	6	11,323	18,577	1.31	24	.32
NM-3	.4	1	15,000	1,067	4.96	5	.04
NM-4	0	0	15,000	0	1.80	0	–
UT-1	*	0	7,200	*	3.60	*	*
UT-2	3.6	1	10,080	4,371	.67	3	.06
UT-3	0	0	21,857	0	2.47	0	–
Rocky Mountain total or average	65.8	27	16,280	66,910	2.76	185	.02

See footnotes at end of table.

Continued–

Appendix table 9–Projected coal production from surface mines, land used for mining, and value of production displaced, by region, State, and Coal Production Areas (CPA's), 1975-99–Continued

Region, State, and CPA	Average annual coal production, 1975-99[1]	New or expanded mines[1]	Coal yield per acre[2]	Average annual acreage taken out of production[3]	Value of production displaced		Ratio[6]
					Per acre[4]	Total[5]	
	Million tons	*Number*	*Tons*	*Acres*	*Dollars*	*1,000 dollars*	*Percent*
Interior:							
AR-1	.5	0	3,000	833	39.26	33	.03
IL-1	7.5	3	4,560	10,024	143.76	1,441	.18
IL-2	0	0	4,200	0	159.10	0	–
IL-3	.4	0	3,960	505	144.04	73	.01
IL-4	.1	0	4,920	102	145.69	15	*
IL-5	18.5	3	8,400	12,812	94.72	1,214	.45
IL-6	5.7	3	6,600	6,118	71.38	437	.17
IN-1	2.5	0	6,000	2,083	91.61	191	.29
IN-2	8.5	3	5,880	9,028	66.21	598	.87
IN-3	24.3	5	5,880	23,663	100.63	2,381	.75
IA-1	.3	0	4,320	347	115.29	40	.02
IA-2	0	0	4,320	0	157.28	0	–
KS-1	0	0	2,040	0	78.74	0	–
KS-2	0	0	1,680	0	52.22	0	–
KS-3	2.6	3	3,000	6,133	54.65	335	.27
KY-1	31.7	4	5,400	31,752	60.48	1,920	.83
MO-1	1.0	0	3,840	1,302	60.42	79	.04
MO-2	0	0	2,760	0	85.52	0	–
MO-3	1.7	0	2,880	2,951	65.77	194	.07
MO-4	1.6	0	2,760	2,899	57.67	167	.12
MO-5	2.5	0	2,640	4,735	55.86	264	.19
OK-1	5.3	2	2,280	12,823	24.93	320	.34
OK-2	1.0	2	3,360	2,688	14.51	39	.15
OK-3	0.5	2	4,440	1,763	11.79	21	.08
Interior total or average	116.0	30	5,040	132,561	73.64	9,762	.14
Eastern:							
AL-1	18.0	7	3,000	32,800	14.63	480	.15
KY-2	2.2	0	5,280	2,083	14.60	30	.35
KY-3	22.3	8	4,920	25,863	17.46	452	.71
KY-4	18.1	3	5,040	19,156	.52	10	1.41
KY-5	15.6	2	5,400	15,244	1.74	27	1.17
KY-6	.8	0	4,800	833	21.60	18	.12
MD-1	2.8	0	4,200	3,333	19.12	64	.48

See footnotes at end of table.

Continued–

Appendix table 9–Projected coal production from surface mines, land used for mining, and value of production displaced, by region, State, and Coal Production Areas (CPA's), 1975-99–Continued

Region, State, and CPA	Average annual coal production, 1975-99[1]	New or expanded mines[1]	Coal yield per acre[2]	Average annual acreage taken out of production[3]	Value of production displaced		Ratio[6]
					Per acre[4]	Total[5]	
	Million tons	*Number*	*Tons*	*Acres*	*Dollars*	*1,000 dollars*	*Percent*
Eastern–Continued:							
OH-1	27.8	2	5,400	26,541	49.01	1,301	.56
OH-2	2.8	1	5,520	2,936	16.52	49	.31
OH-3	1.2	0	6,960	862	9.68	8	.15
OH-4	3.4	0	5,040	3,373	20.74	70	.19
PA-1	6.9	0	5,520	6,250	28.42	178	.19
PA-2	40.7	5	4,680	45,483	25,53	1,161	.39
TN-1	2.8	0	4,680	2,991	13.71	41	.11
TN-2	.2	0	4,320	232	20.42	5	.01
VA-1	14.1	0	5,040	13,988	13.51	189	.67
WV-1	.1	0	5,280	95	14.60	1	.03
WV-2	10.9	3	6,120	10,105	6.64	67	.32
WV-3	1.1	0	5,280	1,042	8.98	9	.13
WV-4	0.5	0	4,920	508	2.16	1	.04
WV-5	7.7	3	5,760	7,884	4.23	33	.27
WV-6	4.7	0	5,520	4,257	4.14	18	.12
Eastern total or average	204.7	34	5,520	225,859	18.65	4,212	.33
Gulf:							
AL-2	0	0	7,140	0	25.36	0	–
AR-2	4.2	1	4,760	5,012	12.80	64	.22
TX-1	33.9	6	10,500	19,743	27.47	542	.21
TX-2	13.6	2	10,500	7,676	32.43	249	.29
TX-3	6.0	3	8,400	5,371	26.09	140	.10
Gulf total or average	57.7	12	[7]10,220	37,802	26.32	995	.16

See footnotes at end of table.

Continued–

Appendix table 9—Projected coal production from surface mines, land used for mining, and value of production displaced, by region, State, and Coal Production Areas (CPA's), 1975-99—Continued

Region, State, and CPA	Average annual coal production, 1975-99[1]	New or expanded mines[1]	Coal yield per acre[2]	Average annual acreage taken out of production[3]	Value of production displaced		Ratio[6]
					Per acre[4]	Total[5]	
	Million tons	*Number*	*Tons*	*Acres*	*Dollars*	*1,000 dollars*	*Percent*
Pacific:							
AK-1	0	0	na	0	–	0	–
AK-2	1.2	1	na	na	0.01	*	–
AK-3	0	0	na	0	0.12	0	–
AK-4	0	0	na	0	0.03	0	–
WA-1	0	0	31,150	0	40.27	0	–
WA-2	0	0	31,150	0	25.25	0	–
WA-3	4.7	1	31,150	1,554	22.52	35	.08
Pacific total or average	5.9	2	[8]31,150	1,554	22.52	35	.02

– = Not applicable.
na = Not available.
*Less than half the indicated unit.
[1] Based on expansion plans of mining companies. For Northern Great Plains, Rocky Mountain, Gulf, and Pacific Regions, plans are those reported to DOE (*92*). For other regions, plans are those reported in 1979 Keystone Manual (*44*).
[2] Computed from data in Averitt (*3*) and U.S. Bureau of Mines (*106*). Based on 80 percent recovery rate and yield of 1,400 tons per acre-foot for lignite, 1,416 for subbituminous, and 1,440 for bituminous.
[3] Computed as follows: $AA = \frac{ACP \times RP}{CY} + APS$, where:

AA = average annual land out of production;
ACP = annual coal production, in tons;
CY = coal yield per acre;
RP = reclamation period = years required for reclamation = 10 years in Rocky Mountain Region, 8 years in Montana and Wyoming, 5 years in North Dakota, and 5 years in other regions;
APS = acres in permanent structures, arbitrarily assumed to be 800 acres for each new or expanded mine in Northern Great Plains, Rocky Mountain, and Pacific Region; 600 acres in Interior and Gulf Regions; and 400 in Eastern Region.

[4] From appendix table 8.
[5] Column 4 x column 5.
[6] Value of production displaced as a percentage of all farm products in the CPA's of the region.
[7] Includes Texas only.
[8] Includes Washington only.

Appendix table 10—Population trends in Coal Production Areas (CPA's), 1940-75

Region, State, and CPA	Total population					Change, 1950-60			Change, 1960-70			Change, 1970-75		
	1940	1950	1960	1970	1975	Total	Natural	Net migration	Total	Natural	Net migration	Total	Natural	Net migration
	Thousands					*Percent*								
Northern Great Plains:														
MT-1	7.8	6.7	6.4	5.8	5.4	−3.2	17.2	−20.5	−10.5	7.3	−17.8	−6.6	0.3	−6.9
MT-2	34.5	34.6	40.2	37.0	35.6	16.3	26.0	−9.7	−8.1	13.2	−21.3	−3.8	4.8	−8.6
MT-3	6.2	5.6	5.6	4.6	4.6	.1	20.4	−20.4	−17.9	7.1	−25.0	−.6	3.7	−4.3
MT-4	26.8	25.4	24.4	22.7	26.4	−3.8	17.0	−20.8	−7.0	12.3	−19.3	16.3	6.2	10.1
MT-5	13.6	15.4	15.7	15.0	14.3	2.3	17.9	−15.6	−4.3	9.1	−13.4	−4.7	2.6	−7.3
ND-1	103.6	111.4	123.1	122.0	122.0	10.4	21.1	−10.7	−.9	14.6	−15.5	nc	4.7	−4.7
ND-2	70.8	69.2	75.4	78.2	85.6	8.9	22.7	−13.8	3.8	14.8	−11.1	9.4	4.9	4.5
ND-3	42.6	41.6	41.5	38.9	38.2	−.2	22.3	−22.5	−6.3	14.3	−20.5	−1.8	3.6	−5.4
SD-1	22.0	20.2	19.4	16.8	17.7	−4.0	21.2	−25.2	−13.5	15.3	−28.7	5.4	6.0	−.6
WY-1	19.2	20.2	19.0	17.8	19.9	−5.9	10.1	−16.0	−6.0	2.3	−8.3	11.8	nc	11.8
WY-2	11.0	9.5	11.3	18.5	18.2	18.8	17.3	1.5	63.6	14.0	49.6	−1.9	5.6	−7.5
WY-3	19.3	21.7	21.3	19.3	24.7	−1.7	16.2	−18.0	−9.4	8.5	−17.9	28.0	4.7	23.3
WY-4	29.7	31.0	26.9	27.0	40.5	−13.2	16.7	−29.9	.3	11.8	−11.4	49.8	7.6	42.2
Northern Great Plains total or average	407.2	412.6	430.4	423.7	453.1	4.3	20.3	−15.9	−1.6	12.9	−14.5	6.9	4.6	2.3
Rocky Mountain:														
AZ-1	68.2	81.1	110.3	128.3	164.4	36.0	49.3	−13.4	16.4	38.0	−21.6	28.1	13.1	15.0
CO-1	15.6	14.9	13.0	12.9	18.1	−12.9	14.2	−27.2	1.2	10.4	−9.2	40.0	6.0	34.0
CO-2	1.8	2.0	1.8	1.8	1.8	−11.0	21.4	−32.4	3.0	12.6	−9.6	.5	11.6	−11.1
CO-3	23.0	20.2	22.0	24.0	29.6	8.8	5.0	3.8	9.6	1.0	8.5	23.1	.2	22.9
CO-4	89.3	97.4	111.2	123.1	142.1	14.2	15.2	−.9	10.6	9.0	1.6	15.4	3.0	12.4
CO-5	29.8	27.9	35.9	34.9	41.4	28.6	23.2	5.4	−2.8	12.1	−14.9	18.7	4.6	14.0
CO-6	48.5	36.5	27.9	22.4	22.1	−23.6	11.3	−34.9	−19.8	4.3	−24.1	−1.4	−.6	−0.9
CO-7	246.0	342.8	655.3	1,042.0	1,297.0	91.1	27.7	63.5	59.0	18.8	40.2	24.5	7.1	17.4
NM-1	17.1	18.3	53.3	52.5	65.3	191.4	63.2	128.2	−1.5	24.9	−26.4	24.3	9.6	14.7
NM-2	37.5	39.9	51.4	60.7	73.8	28.9	34.7	−5.8	18.1	33.1	−15.0	21.6	11.7	9.9
NM-3	18.7	16.8	13.8	12.2	12.9	−17.6	14.9	−32.5	−11.8	11.6	−23.4	6.0	3.5	2.5
NM-4	11.4	9.7	10.2	9.8	9.8	5.1	23.1	−18.0	−4.0	21.9	−25.9	.4	7.6	−7.2

See footnotes at end of table.

Continued—

Appendix table 10–Population trends in Coal Production Areas (CPA's), 1940-75–Continued

Region, State, and CPA	Total population					Change, 1950-60			Change, 1960-70			Change, 1970-75		
	1940	1950	1960	1970	1975	Total	Natural	Net migration	Total	Natural	Net migration	Total	Natural	Net migration
	Thousands					*Percent*								
Rocky Mountain–Continued:														
UT-1	37.6	43.3	37.2	30.9	36.1	−13.9	19.4	−33.4	−17.1	8.3	−25.4	16.9	5.6	11.3
UT-2	10.2	8.7	8.0	7.2	8.2	−7.9	20.6	−28.4	−11.4	12.5	−23.9	13.6	2.5	11.1
UT-3	9.9	10.3	11.6	12.7	17.3	12.4	26.0	−13.6	9.5	20.2	−10.7	36.4	12.0	24.4
Rocky Mountain total or average	664.7	769.6	1,162.8	1,575.5	1,939.9	51.1	26.9	24.2	35.5	19.2	16.3	23.1	7.2	15.9
Interior:														
AR-1	186.2	169.0	155.1	183.4	228.9	−8.3	14.1	−22.4	18.3	10.3	8.0	24.8	3.2	21.6
IL-1	630.8	673.7	714.0	748.2	747.7	6.0	11.7	−5.7	4.8	8.1	−3.3	−.1	2.3	−2.4
IL-2	500.0	557.3	683.3	794.7	848.4	22.6	15.8	6.9	16.3	11.6	4.7	6.8	5.0	1.8
IL-3	548.6	561.4	590.6	608.6	618.7	5.2	10.8	−5.6	3.0	6.7	−3.7	1.6	1.4	.2
IL-4	197.8	195.4	207.3	211.4	210.7	6.1	11.1	−4.9	2.0	5.9	−3.9	−.4	2.0	−2.4
IL-5	462.7	530.1	631.6	703.2	694.4	19.1	16.7	2.4	11.3	11.0	.3	−1.2	3.4	−4.6
IL-6	357.0	337.6	300.6	291.2	299.2	−11.0	6.3	−17.3	−3.1	1.5	−4.6	2.8	nc	2.8
IN-1	57.0	532.3	51.2	49.6	50.5	−3.8	7.6	−11.4	−3.0	3.6	−6.6	1.7	1.1	.6
IN-2	164.1	164.5	165.8	170.5	167.6	.8	8.3	−7.5	2.9	4.3	−1.4	−1.7	1.3	−3.0
IN-3	385.4	413.5	417.2	434.4	435.0	.9	13.7	−12.8	4.1	7.7	−3.6	−.1	1.8	−1.9
IA-1	126.9	121.9	117.0	110.2	108.5	−4.0	10.0	−14.0	−5.8	3.9	−9.7	−1.6	.3	−1.9
IA-2	725.5	772.9	838.6	894.4	920.8	8.5	13.8	−5.3	6.7	9.5	−2.8	2.9	2.7	.2
KS-1	97.5	92.8	95.5	96.0	96.1	2.9	10.4	−7.5	.5	5.6	−5.1	.1	1.7	1.8
KS-2	36.0	32.7	32.4	33.3	33.7	.9	7.0	−7.9	2.9	2.8	.1	1.0	0.7	.3
KS-3	145.1	131.5	121.5	117.4	115.7	−7.6	6.2	−13.7	−3.4	−.9	−4.3	−1.4	2.2	−.8
KY-1	325.5	317.5	330.6	345.0	376.0	4.1	13.9	−9.8	4.3	8.4	−4.1	9.0	3.6	5.4
MO-1	138.2	120.8	106.2	101.8	102.4	−12.1	4.6	−16.8	−4.1	.1	−4.0	.5	−.7	1.2
MO-2	153.7	155.2	192.4	228.4	240.2	24.0	11.1	12.9	18.7	8.2	10.5	5.1	3.2	1.9
MO-3	214.8	214.0	213.9	235.1	245.7	−.1	7.3	−7.3	9.9	4.9	5.0	4.5	1.5	3.0
MO-4	109.9	102.1	121.4	133.9	145.4	18.9	7.5	11.4	10.2	5.4	4.9	8.6	2.8	5.8
MO-5	160.9	152.0	143.2	141.1	147.6	−5.8	5.3	−11.1	−1.5	1.2	−2.7	4.6	−.1	4.5

Continued

Appendix table 10—Population trends in Coal Production Areas (CPA's), 1940-75—Continued

Region, State, and CPA	Total population					Change, 1950-60			Change, 1960-70			Change, 1970-75		
	1940	1950	1960	1970	1975	Total	Natural	Net migration	Total	Natural	Net migration	Total	Natural	Net migration
	Thousands					*Percent*								
Interior—Continued:														
OK-1	428.9	463.9	532.4	594.8	625.4	14.8	15.6	−0.8	11.7	9.6	2.2	5.1	3.2	1.9
OK-2	86.3	68.4	56.2	65.1	71.2	−17.7	10.6	−28.4	15.8	7.8	7.9	9.4	3.6	6.8
OK-3	92.9	73.0	58.0	62.6	63.7	−20.6	9.6	−30.2	8.0	4.1	3.8	1.7	.9	0.8
Interior total or average	6,332.5	6,474.7	6,876.1	7,354.6	7,593.5	6.2	12.1	−5.9	7.0	7.7	−.7	3.2	2.5	.7
Eastern:														
AL-1	887.3	1,000.8	1,057.6	1,100.4	1,164.8	5.7	16.8	−11.1	4.0	9.9	−5.9	5.8	3.4	2.4
KY-2	88.1	89.2	93.5	96.3	98.2	4.8	17.7	−12.9	2.9	11.2	−8.2	2.0	3.2	−1.2
KY-3	315.4	281.0	243.2	234.1	258.9	−13.5	17.6	−31.1	−3.7	12.4	−16.1	10.6	3.9	6.7
KY-4	206.7	206.2	167.6	144.2	163.1	−18.7	21.0	−39.7	−14.0	13.6	−27.6	13.1	5.3	7.8
KY-5	220.1	213.4	158.2	129.9	141.5	−25.9	18.7	−44.6	−17.8	12.7	−30.5	8.9	5.2	3.7
KY-6	70.7	43.7	36.0	35.0	38.5	−17.6	17.4	−35.0	−2.9	12.1	−15.0	10.0	3.4	6.6
MD-1	109.0	110.8	104.6	105.5	107.1	−5.6	9.7	−15.4	.9	6.7	−5.8	1.5	1.9	−.4
OH-1	1,122.9	1,198.3	1,336.7	1,379.2	1,417.4	11.5	14.4	−2.8	3.2	8.1	−4.9	2.8	2.9	−.1
OH-2	72.4	69.0	75.4	80.0	84.1	9.3	10.7	−1.4	6.0	6.9	−.8	5.2	2.8	2.4
OH-3	67.7	65.4	67.2	75.2	73.7	2.8	9.7	−7.0	12.0	8.2	3.8	−2.0	3.8	−5.8
OH-4	220.9	218.7	227.6	215.5	229.8	4.1	13.6	−9.5	−5.3	7.2	−12.5	6.6	2.6	4.0
PA-1	2,173.3	2,325.2	2,512.6	2,485.2	2,409.8	8.1	13.5	−5.4	−1.1	6.6	−7.7	−3.0	1.1	−4.1
PA-2	1,746.4	1,746.4	1,769.6	1,778.5	1,822.3	1.3	12.6	−11.2	.5	7.4	−6.9	2.5	3.1	−.6
TN-1	196.2	239.8	227.4	225.0	243.7	−5.2	18.1	−23.2	−1.1	11.3	−12.4	8.3	3.5	4.8
TN-2	287.3	321.7	348.5	373.0	398.6	8.3	17.0	−8.7	7.0	10.5	−3.5	6.8	3.9	2.9
VA-1	239.7	253.6	228.2	197.1	212.0	−10.0	18.6	−28.6	−13.6	9.8	−23.4	7.5	1.9	5.6
WV-1	170.4	169.8	175.0	171.2	171.6	3.0	13.0	−9.9	−2.2	6.8	−9.0	.2	2.2	−2.0
WV-2	389.8	397.8	355.6	349.6	367.8	−10.6	10.9	−21.5	−1.7	6.3	−7.9	5.2	2.1	3.1
WV-3	44.2	41.7	38.4	39.2	41.0	−7.9	11.1	−19.0	2.0	9.5	−7.6	4.7	2.7	2.0
WV-4	85.0	74.4	60.6	51.4	53.5	−18.5	12.0	−30.5	−15.1	7.2	−22.4	4.0	1.5	2.5

See footnotes at end of table.

Continued—

Appendix table 10—Population trends in Coal Production Areas (CPA's), 1940-75—Continued

Region, State, and CPA	Total population					Change, 1950-60			Change, 1960-70			Change, 1970-75		
	1940	1950	1960	1970	1975	Total	Natural	Net migration	Total	Natural	Net migration	Total	Natural	Net migration
	Thousands					*Percent*								
Eastern—Continued:														
WV-5	545.6	626.3	610.4	558.4	562.9	−2.5	18.4	−20.9	−8.5	9.6	−18.1	0.8	3.5	−2.7
WV-6	456.6	488.8	399.6	340.1	358.4	−18.3	16.5	−34.8	−14.9	7.2	−22.1	5.4	3.1	2.3
Eastern total or average	9,698.5	10,182.0	10,293.7	10,164.0	10,418.7	1.1	14.7	−13.6	−1.3	8.1	−9.4	2.5	2.6	−.1
Gulf:														
AL-2	253.0	226.0	211.0	222.0	216.0	−6.5	19.0	−25.5	5.3	14.2	−8.9	−3.0	5.6	−8.6
AR-2	231.0	275.0	322.0	374.0	419.0	17.2	18.8	−1.6	15.9	13.4	2.5	12.1	5.4	6.7
TX-1	758.0	893.0	1,040.0	1,196.0	1,305.0	16.3	20.9	−4.6	15.0	14.3	.7	9.1	5.5	3.6
TX-2	223.0	204.0	197.0	199.0	206.0	−3.6	15.2	−18.8	1.0	7.6	−6.6	3.3	2.0	1.3
TX-3	266.0	239.0	231.0	263.0	300.0	−3.0	13.4	−16.4	13.7	8.4	5.3	14.0	2.8	11.2
Gulf, total or average	1,732.0	1,837.0	2,001.0	2,254.0	2,445.0	8.9	18.8	−9.8	12.6	12.8	−.2	8.5	4.9	3.6
Pacific:														
AK-1	[1]	1.4	2.1	[2] 3.5	4.2	49.0	54.5	−5.5	61.8	40.4	21.4	21.7	5.9	15.8
AK-2	[1]	21.5	47.5	54.8	59.0	120.5	59.2	61.3	15.3	29.1	−13.8	7.7	11.1	−3.4
AK-3	[1]	3.6	5.2	6.5	10.6	44.4	25.5	18.9	25.5	17.4	8.1	62.8	7.5	55.3
AK-4	[1]	5.1	9.1	16.6	18.5	79.2	31.8	47.4	83.2	16.6	66.7	11.5	7.3	4.2
WA-1	60.4	66.7	70.3	82.0	90.6	5.4	11.7	−6.3	16.5	5.7	10.8	10.6	3.0	7.6
WA-2	707.3	1,031.1	1,277.1	1,592.7	1,584.4	23.9	15.6	8.3	24.7	11.9	12.8	−.5	3.2	−3.7
WA-3	78.7	88.6	96.9	122.4	142.1	9.3	12.6	−3.3	26.3	9.2	17.0	16.1	3.5	12.6
Pacific total or average	[1]	1,218.1	1,508.2	1,878.4	1,909.4	23.8	16.0	7.8	24.5	12.1	12.4	1.6	3.4	−1.8

nc = No change.
[1] Not available.
[2] Revised data from *Current Population Reports,* Series P-25, No. 638 (*87*). A portion of the 1960-70 change was due to a change in Census District boundaries.

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